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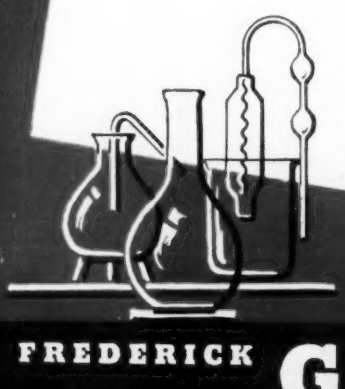

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Burring, Buffing and Polishing . . . Manufacturers and Specialists in the Development of Production Methods and Compositions

VOL. 44, NO. 3 METAL FINISHING MARCH, 1946
PREPARATION, ELECTROPLATING, COATING

Sales Engineering as a Calling

Curtailment of operations has included elimination of finishing departments in a considerable number of war plants and one of the immediate effects has been an increasing availability in the labor market of young, technically trained men who entered the plating field early in the war period. Technical training has enabled these men to take full advantage of their opportunities so that, in general, they have obtained an excellent foundation in metal finishing theory and practice.

Due to the technical manpower shortage throughout the war years, a good many of these men started at the top of the ladder rather than at the bottom, and often commanded salaries all out of proportion to their experience. Unfortunately, metal finishing employment offerings in civilian production are not as remunerative for men with two to five years experience, obtained in only one or two positions, and an understandable hesitation to return to the plant has been noted. For those men who think they could develop into sales engineers, we strongly recommend this outlet for their abilities.

The manufacturer and distributor of metal finishing processes, equipment and supplies prefer a technical man with some practical metal finishing background since such a salesman has a better understanding of the customer's requirements. This tends to create good will, as suppliers are often called upon for technical assistance and the sale of unsuitable materials can be avoided if one is familiar with the technical aspects of the various processes.

From the standpoint of the technical man, sales work has much to offer, even if he decides later to return to the finishing room. Metal finishing is a highly practical field, despite recent technological advances. Visiting many plants and observing their practices, the sales engineer is afforded opportunities to gain information, which are not available to the production man, and can make contacts which may later prove to be of great value.

The sales engineer has an important place in metal finishing. His entrance on the scene is of mutual advantage to himself, his employer and the customer. We suggest that this well-paying pursuit be given serious consideration by all young technical men, interested in augmenting their knowledge. Experience always commands a price and we can think of no better way to obtain it in this industry.

METAL SURFACE PREPARATION FOR BLACK OXIDE FINISHING

By ARTHUR P. SHULZE

Petersburg, Virginia

DESIGNED and brought across the past decade to their present high state of development in response to industry's steadily increased demands for a quickly-applied, corrosion-resistant, comparatively-economical finish, black oxide coatings enjoyed wide utilization during the war for finishing a long list of ordnance materiel and other then vitally-needed supplies required to equip and maintain Allied fighting forces on world-wide battlefronts.

The marked success attending the diverse applications of these coatings over this critical period indicates pointedly that now, with the manufacture of long-scarce civilian goods again moving into high gear, black finishing is destined to occupy a still broader role in numerous production lines as a dependable means of providing either a final protective finish or an undercoating for organic finishes.

Proper surface preparation of work long has been universally recognized among finishing department superintendents and foremen as a basic step in electroplating, anodizing, rust-proofing, galvanizing, painting, lacquering, enameling, japanning or other industrial protective coating techniques. It is, likewise, a prime requisite in black oxide finishing. On this score virtually all authorities are in complete accord.

Close examination and study of technical literature and specific process recommendations by various manufacturers confirm this beyond question. In steel finishing, for example, one says, simply, "the work must be cleaned"; in chemically finishing copper, this same manufacturer stresses the need of surface preparation more strongly, asserting: "Preparation of the metal surface is very important; it must be mechanically and chemically clean." A second, outlining certain methods for blacking zinc, zinc-plated fabrications and zinc die castings, cautions: "Be sure that all pieces are chemically clean before processing."

Still another authority aptly summarizes this requirement of chemical cleanliness thusly: "A clean surface is ESSENTIAL before a durable, attractive and satisfactory finish can be produced." The fundamental truth of this axiom, as a matter of plain fact, never has been more evident than it is in the application of black oxide finishes to ferrous and non-ferrous metals. With every proprietary blackening treatment, successful results depend to an appreciable degree upon the procurement of a grease-free, chemically-clean basis metal surface for a trio of reasons, each exceedingly important. They are as follows:

(1)—Critical conditions, under which most black oxide coatings are produced, make it imperative that surfaces of parts scheduled for finishing be completely free of any foreign matter which may impede or otherwise interfere with the action of the blackening bath. As plant experience has demonstrated time and again, a non-uniform, mottled appearance is apt to result if oil, grease, drawing and stamping compounds, shop dirt, oxide film, scale and rust are not removed from surfaces of work to be blackened.

(2)—Blackening baths utilized in the chemical oxidizing processes are highly susceptible to contamination by foreign matter carried over to the work to be finished. Obviously, it follows, therefore, that the cleaner the work, the less frequent is the need to replace the blackening solution.

(3)—In these days of rising production costs, it has become increasingly essential to prevent entirely or hold to an absolute minimum losses due to rejected work. In the application of black oxide coatings, there are numerous points at which the cause for rej can be created. Prominent among the more common ones, accordi to accumulated production experience, is incorrect or incompl surface preparation.

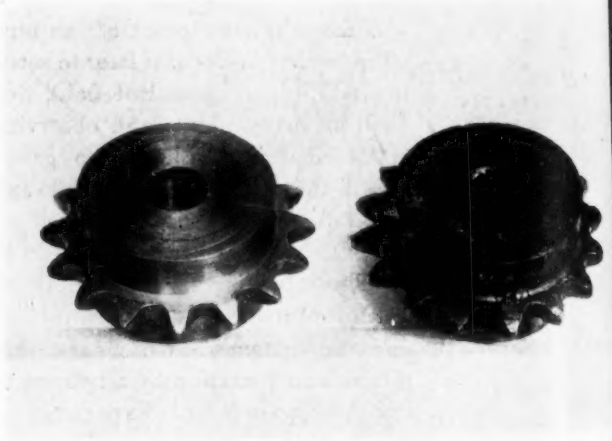
Is it any wonder, then, that manufacturers of chemicals used connection with blackening metals so emphatically underline t importance of proper surface preparation. The operation of clean is the initial step in the processing cycle. No matter what particu proprietary blackening technique may be employed, cleaning co FIRST.

A number of methods or procedures are available for prepar ferrous and non-ferrous metals effectively, speedily, and at low c for black oxide finishing. Final choice in any given instance depe upon several variables. Among them are, chiefly: type of metal alloy to be processed, character and extent of deposits acquired work in previous stages of fabrication, equipment available for s face preparation, and volume of output required.

In current production practice, four procedures are general employed: (1) solvent degreasing; (2) emulsifying-solvent degre ing; (3) alkaline cleaning, and (4) electrocleaning. Depending individual plant conditions encountered, these methods are used, the most part, either separately or in certain combinations as a t step treatment. The latter practice is the case where pre-cleani of work is required, due to extremely soiled condition of parts other factors. For the purpose of simplicity, the following bri discussion of cleaning materials and methods is divided according the type of metal involved.

Iron and Steel

Alkaline Degreasing: Where foreign matter on iron and st consists of ordinary cutting or grinding lubricants, rust-retarding o



(Courtesy Oakite Products, Inc., New York)

Condition of sprocket at right shows need for pre-cleaning. Grease-free, smut-free appearance of part illustrated at left is evidence of effectiveness of alkaline or emulsifying-solvent type materials often employed for pre-cleaning.

metal chips and shop dirt, the tank method has proved very popular. Immersion of work for five minutes or so in a hot solution of any one of a number of suitable alkaline cleaners assures fast, effective removal of these deposits that prevent efficient application of a black oxide finish. Temperature, 180° F.

After cleaning, the work should be thoroughly rinsed. Depending upon facilities available, a hot or cold rinse may be employed, although the former is usually recommended. The rinse tank should, if possible, be maintained at approximately 180° F.; otherwise measures should be taken to provide a cold running rinse tank so as to assure a constantly clean rinse and complete removal of emulsified oil and grease.

Electrocleaning: As received from the mill, cold rolled steel sheet or strip occasionally carries smut deposits consisting of carbon and iron carbides. Polished steel surfaces may also acquire a smut, formed largely of fine abrasive and metal particles and polishing lubricant. In addition, surfaces or parts, during manufacturing operations, usually pick up deposits of machining oils, grease, drawing compounds and shop dirt. In cases like these, electrocleaning often may be employed with satisfactory results.

Here, materials specially designed for anodic degreasing are used. One typical recommendation is: 6 to 10 ounces cleaner per gallon of water; temperature, 190°-210° F.; current density, 40 amperes per square foot, reverse current. A solution of this type has high conductivity, long life, active emulsifying characteristics and high lime

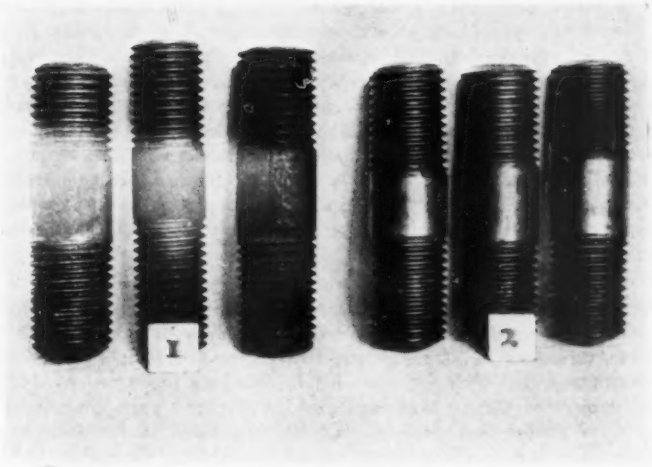
(Courtesy Oakite Products, Inc., New York)

Racking small parts for still-tank alkaline degreasing or electrocleaning is time-consuming . . . added reason for selecting correct cleaning compound to assure proper surface preparation of work by this method so that rejects and re-handling may be either minimized or entirely avoided.

tolerance, all important qualities incident to effective electrocleaning by reverse current.

Pre-Cleaning: To rid ferrous parts of heavy, tenacious lubricants frequently used in critical deep drawing and heavy machining operations, pre-cleaning is required in many instances before alkaline cleaning or electrocleaning. This operation may be satisfactorily handled in three ways. One is solvent degreasing. In other cases, "pre-soaking" of work in a solvent-type material different from the ordinary solvent degreasers is indicated. In still others, an alkali bath, made up with a material combining emulsifying and wetting-out properties, is employed. It should be mentioned that where parts are washed with solvents, a second cleaning operation (either alkaline cleaning or electrocleaning, as mentioned earlier) is necessary to produce the chemically-clean surfaces required for black finishing.

Scale and Rust Removal: Since black oxide finishes are chemical processes which cause definite chemical changes in the surface of the work to be treated, a clean, scale-free surface on the iron or steel part, more active than a surface covered with foreign matter, actually adds to the effectiveness and speed of the finishing operation. Importance of this fact frequently has been verified in numerous instances wherein the cause of a spotty, non-uniform black finish was traced back to incomplete removal of scale and rust deposits. Surface oxides develop either in the production of the metal as in the case of mill scale or in one of the many heat-treating operations as in the case of



(Courtesy Oakite Products, Inc., New York)

In addition to being covered with a film of grease and shop dirt, the stud bolts shown at left in above photograph have a coating of rust. After cleaning, treatment with suitable acid removes rust deposits, preparing iron and steel surfaces for subsequent blackening treatment.

annealing and carburizing scales. Rusting occurs, of course, when work is left unprotected under conditions conducive to rust formation.

Where oxide, scale or rust films are present on work, acid dipping or pickling follows degreasing. Formulas and methods for handling this operation vary so widely from one plant to another because of such factors as differences in manufacturing practices and character and thickness of deposits encountered, that it is impractical to make recommendations for a standard pickling procedure which will satisfactorily meet every production requirement.

Two of the most commonly used pickling agents, each employed alone either as a single acid treatment or with each other consecutively as a two-bath treatment, are sulfuric acid and hydrochloric acid, which are employed mostly for volume production pickling purposes. Sulfuric acid is generally used at a concentration of from 5% to 10% by volume, depending on type and amount of scale to be removed, production rate and tank capacity. Temperature of solution ranges from 120° to 190° F. Hydrochloric acid is frequently used at room temperature at a concentration of from 10% to 50%, this also depending on the same general conditions as noted above.

Having faster action at room temperature than sulfuric, hydrochloric acid is more preferable for light oxide films, such as those found on polished steel. Sulfuric acid, on the other hand, has the advantage of lower cost. As indicated, it may be heated in a lead lined tank with lead steam coils, lead pipe immersion gas heaters or lead sheathed electric units; hydrochloric acid requires a carbon, fused silica, or tantalum coil or sheathing and tanks with rubber, brick or suitable organic linings which are more expensive.

The action of these two acids, however, when used in their original state respectively for descaling or rust removal, is uncontrolled, i. e., the acid, after having removed the adherent rust and scale does not stop there but continues to attack the sound basis metal. For this reason, addition of suitable inhibitors to the acid bath has become universal practice throughout industry to reduce or control attack of the acid on the clean basis metal without appreciably retarding the rate of scale or rust removal by the acid. They conserve acid, minimize pitting of the metal or eliminate over-pickling, and reduce the severity of hydrogen embrittlement and acid fumes.

Various unusual or special oxide, scale and rust conditions and problems arise from time to time, however, where the regular acid dips and pickling solutions fail to provide the required results. In such occasional instances, many plants find the use of specialized materials highly advantageous. While not suggested as a replacement for those acid baths regularly employed in volume production pickling, they satisfactorily dissolve, nevertheless, numerous types of oxide, scale and rust accumulations or films which resist removal by commercial raw acids, and do this with less action on iron and steel. The materials, moreover, induce very little hydrogen embrittlement and in some cases none at all.

Neutralizing: After descaling and rust removal by acid treatment of any type, work should be neutralized so as to nullify the effects of any residual acid in the pores of the metal. When the surface preparation cycle is relatively simple and the volume of output small, the alkaline cleaning tank may also be utilized as a neutralizing bath. In the interest of high-speed, straight-line production, however, a separate neutralizing bath is advisable. A number of suitable alkaline materials are readily adaptable for neutralizing operations; they are extremely free-rinsing, a property of considerable importance in the preparation of iron and steel for black oxide finishing.

Complex metallurgical structure of non-ferrous alloys, creates a great many different and unusual surface preparation problems and conditions not ordinarily experienced in working with ferrous metals. Wide variations in chemical sensitivity, types of surface deposits present and similar factors have led to searching investigations into the subject by various organizations. For the most part, the results of these studies and analyses may be crystallized in the form of general recommendations which, while applicable to the majority of instances where black finishes or coatings are applied to non-ferrous metals and alloys, must frequently be adapted in some degree to meet the particular conditions encountered in certain individual cases. These findings are capsulized in digest style below to conserve space and to facilitate quick easy reading.

Copper

Still Tank Method: Pure copper does not tarnish as readily as do many of its alloys. Use solution of recommended alkaline material to remove ordinary machining oils, drawing lubricants, etc. Temperature, 180°-200° F. Hot water rinse or cold running rinse follows. Solvent degreasing, however, is an alternate method cleaning.

Electrocleaning Technique: Where unusually heavy deposits of polishing and buffing compounds, oil, grease and other similar soil indicate need for electrocleaning, work is first pre-cleaned as described in preceding paragraph and then cleaned cathodically or anodically with a material specially designed for application by this method. Concentration of solution, 6 to 10 ounces per gallon of water; temperature, 190°-210° F.; current density, 20 to 40 amperes per square foot; time, 30 seconds to 3 minutes.

Brass and Bronze

Still Tank Degreasing: In preparing brasses and bronze for black finishing, an important factor is the removal of not only surface contaminates but also of metallic oxides, usually termed "tarnish." For removing light oils, grease, dirt, etc., various specially designed alkaline degreasing agents are available. Concentrations range from 4 to 8 ounces per gallon of water at 180°-200° F., depending upon character, amount and tenacity of foreign matter present. Alkaline brass cleaners usually should be boiled thoroughly to expel the oxygen which might cause excessive tarnishing.

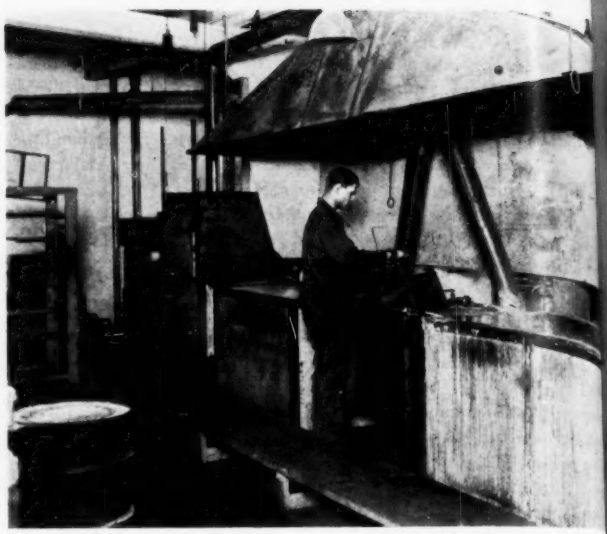
Work is rinsed thoroughly after cleaning. Unless immediately processed by subsequent blackening, it is dried thoroughly by suitable means or held in clear, cold running rinse tank. Cleaning of brass and bronze may also be handled with a solvent degreaser.

Detarnishing: Slight tarnish on alkali-cleaned brass is often unavoidable. Usual tarnish of this kind, however, may be removed in a weak acid or cyanide solution used at room temperature. Three dips recommended are: (1) sodium cyanide, 6 ounces per gallon of water; (2) sulfuric acid, 5-15%; or (3) hydrochloric acid, 10%. Safety precaution: never mix the cyanide and acid solution, this for the reason that a very poisonous gas results. Dip is followed by thorough cold running rinse to remove all trace of acid solution.

Where a stronger action is desired for copper and its alloys, bright dips consisting of nitric and sulfuric acids in widely varying proportions, together with a small quantity of water and hydrochloric acid, are employed. One typical formula that, with necessary variations to suit individual requirements, produces a satisfactory finish is:

Sulfuric acid	2 gal.
Nitric acid	1 "
Water	1 qt.
Hydrochloric acid	½-1 oz.

Room temperature.



(Courtesy Oakite Products, Inc., New York)

An alkaline degreasing and rinsing tank arrangement, similar to this typical cleaning installation, is one effective, fast, economical way to prepare ferrous and non-ferrous metals for black oxide finishing. Small parts may be handled in a basket.

Another but less hazardous etch, also used cold, is a dichromate pickle, made up as follows:

Sulfuric acid	2 fl. oz.
Sodium dichromate	12 oz.
Water	1 gal.

Bright dip solutions heat up during use and should not be allowed to get above room temperature whenever possible. Solutions may be kept cool by immersing crock, or other receptacle holding the bright dip solution, in a cold running water bath.

Deoxidizing and Descaling: Various formulas may be employed depending on conditions. One pickle formula recommended is:

Sulfuric acid	1 gal.
Water	9 "

Temperature: 125°-175° F.

On copper and copper alloys exceeding about 85% in copper content, oxide films possess a high percentage of cuprous oxide which is not readily removed by sulfuric acid pickles. In such instances, addition of an oxidizing agent is desirable. Examples of such solutions are these dichromate and ferric sulfate pickles:

Sulfuric acid	1 pt./gal.
Sodium dichromate	2-4 oz./gal.

Temperature: Room to 175° F.

Sulfuric acid	13 oz./gal.
Ferric sulfate	13 "

Temperature: Low copper alloys, 120°-140° F.
High copper alloys, 140°-175° F.

After pickling and prior to bright dipping, preliminary smoothing of the surface is frequently followed to increase the life of the bright dip and to secure a more uniform finish. The solution, called a "Scaling" or "Fire-Off" dip, is composed of:

Sulfuric acid	2 gal.
Nitric acid	1 "
Water	5 "

Agitate the work. If action is too rapid, increase sulfuric acid content. Where parts are scale-coated, treatment in pickling solution or "scaling" dip is advisable before bright-dipping.

Electrocleaning: Due to the vigorous action which it provides, electrocleaning of brass and bronze is advantageous in many instances. Reverse or direct current is applied. Use recommended alkaline detergent in cleaning tank, at 6 to 8 ounces per gallon of water, 180° to 200° F. Current density, 20 to 40 amperes per square foot. To remove any light tarnish that forms, dip work in acid solution (5 to 15% sulfuric acid or 10% hydrochloric acid) then follow with thorough cold running rinse to rid parts of last trace of acid solution.

Aluminum

Two types of surface contaminates are usually found on aluminum and aluminum alloy parts. First, residual machining and forming lubricants, rolling oil, shop dirt and identification paint; and second, metallic oxide. All deposits must be effectively, safely removed for proper black finish adhesion. For handling the first type cleaning operation, various methods are available.

Solvent Degreasing: Solvent cleaning may be accomplished either by (a) manual application of mineral spirits or other high-flash point petroleum solvents; (b) dip-tank method, or (c) solvent degreaser, which overcomes most difficulties associated with this cleaning procedure. It should be remembered, however, that certain precautions, including adequate ventilation and care in handling the liquid, must be taken in using vapor degreasing equipment. Solvent degreasing is often a preliminary step to alkali cleaning, and where performed in connection with applying a chemical finish on aluminum, must always be followed by alkaline cleaning to assure chemically-clean surfaces required for black finishing.

Alkaline Cleaning: For oil and grease removal, alkaline cleaners which have been inhibited to prevent attack of the aluminum, also enjoy wide use. There are a number of proprietary cleaning compounds of this type commercially available which are entirely satisfactory for use on aluminum. Before using these cleaners, however, they should be tested to make certain they will not attack the metal. Materials which are not free-rinsing should not be used. With this method, parts are immersed for about 3 minutes in the recommended solution, maintained at a temperature of 160°-180° F., after which they are thoroughly rinsed and dried, unless an acid dip is to be subsequently employed.

Deoxidizing: Alkaline cleaning is usually followed by dilute acid treatment to deoxidize work. Chromic acid and phosphoric acid, the most common ones employed, are used in solutions containing 5% of either. In the case of the chromic acid solution, the bath is maintained at a temperature of 120°-140° F., while the phosphoric acid may be used at room temperature. After treatment in the inhibited alkaline cleaner and rinsing, work is immersed in the acid solution for about 5 minutes, then thoroughly rinsed and dried.

Another type of acid treatment, one of the most effective of the simple chemical cleaning treatments, involves the use of aqueous solutions of phosphoric acid with organic grease solvents, together with wetting agents, emulsifying agents, etc. There is a variety of proprietary mixtures of this type on the market, which may be applied with brush or swab, by dip-tank, or by mechanical washing machines, where large quantities of aluminum parts are to be cleaned.

In some ways, due to the fact that their action is slower and the time of their application much less critical, mild acids with sulfur basis are said by some authorities to be superior to other forms of oxide-removing chemicals. Preparations of this type attack oxides comparatively rapidly and their action on the metal itself after the removal of oxides, is considerably delayed so that an appreciable tolerance in the time of exposure can be permitted. One manufacturer says, however, that there should not be too long an interval between surface preparation and subsequent finishing operations.

Zinc

Still Tank Method: As with copper blackening, surface preparation is very important when processing zinc. Since rolled zinc sheets, zinc-coated parts and zinc base alloy die castings are sensitive to strongly alkaline solutions, extreme caution should be exercised in the selection of a material for degreasing work of this type. Cleaning is generally a critical operation, particularly from time standpoint, if attack on metal is to be avoided. Mildly alkaline materials are advised, and are applied by either one or two-tank procedure, depending on extent and character of surface contamination.

Electrocleaning: For removing tenacious grease, buffing compounds, etc., use a specially designed material in electrocleaning tank. Concentration, 2 to 8 ounces per gallon of water, 160° F. Current density, 20 to 40 amperes per square foot.

Removing Oxide: To obtain the even, dull gray-black appearance on zinc die castings required for a sharp black finish, immerse clean parts in 50% solution hydrochloric acid and water. Reduce concentration for pure zinc fabrications to 25% solution of hydrochloric acid and water. Follow with cold running rinse.

For some zinc work, a pre-dip following alkaline cleaning is recommended before work goes to blackening bath. One suggested dip, used cold, is: nickel-ammonium sulfate, ½ ounce to a gallon of water. Another dip which may be more satisfactory for some work consists of 1 oz. caustic soda and 1 oz. sodium cyanide per gallon of water, operated at about 140° F. Advantage of this particular dip is that parts which are not uniformly colored after processing, due to poor surface condition, may be immersed in this dip, then reprocessed. This will usually give a satisfactory finish.

Chromated Parts

Where cadmium or zinc-plated surfaces are "chromate-blackened" immediately after the plating procedure, no cleaning is necessary. However, if parts have been allowed to stand long enough after plating to have collected dirt, grease, or to have become oxidized, they must be degreased and deoxidized before chromating and subsequent blacking with dye, due to the fact that the chromate cannot form its protective coating unless the surface is entirely free from foreign matter. For degreasing, parts are immersed in a standard hot alkaline cleaner until surface oils and greases are completely removed. Subsequent bright-dipping in a ½ to 1% nitric acid bath then removes any oxide formations present.

In chromate-blackening of zinc die castings, it is not necessary to condition the surface by zinc-plate flashing but to clean the work in a hot anodic type cleaner, *without current*, at 200° F. at a concentration of 12 ounces per gallon for several minutes. After a cold running rinse, work is neutralized in a hydrochloric or sulfuric acid solution of from 1% to 10% at room temperature for a few seconds. Chromating and blackening with dye follow.

The all-around serviceability and attractiveness of any black oxide coating depends in large measure upon the selection of the proper surface treatment and blackening process. It has not been possible, of course, to cover in this article all phases of surface preparation. Nothing has been said, for example, about important points to bear in mind in connection with construction and operation of still and electrocleaning tanks. Yet it is hoped that sufficient information has been provided to enable the user to select the correct technique for most any given type of work.

Cover of Metal Industry, 1904 (now *Metal Finishing*).

All Our Yesterdays

PART II

By GEORGE SPELVIN

1904 began omniously. Labor unrest was still abroad in the land, and the year was marked by many major strikes and much violence, on both sides. Early in February the greatest fire since the Chicago holocaust broke out in Baltimore, burned thirty hours, and destroyed 2,600 buildings with a loss of $125,000,000. On the same day the Japanese fleet attacked the Russian at Port Arthur, and the Russo-Japanese war was on.

In March and April the coal miners accepted a wage reduction of 5.5 to 6%. In May the passing of the frontier was signalized by the last large government land grant to settlers: 382,000 acres in South Dakota. In June the excursion steamer "General Slocum" burned and sank in New York's East River, with the loss of more than 900 lives, mostly women and children.

It was a presidential year: politics filled the newspapers and partisanship ran high. A Roosevelt was running for a second term, this time on the Republican ticket—but there were no radios, and the candidates were forced to campaign the hard way.

But the reader of the technical journals devoted to electroplating and the allied arts would have gleaned none of this information; his reading would have been along these lines:

Item: is caustic potash better than caustic soda for degreasing? Yes, says the author, for KOH forms soft soaps while NaOH forms hard soaps. The hard soaps are less soluble and therefore tend to form a scum on the work. But, the reader is warned, don't buy any but the very best grades of caustic potash.

Here's an editorial calling attention to the hazards attending the use of cyanides in the plating room. Two workmen, it appears, were recently killed by HCN fumes. HCN, the editor reminds us, is the most powerful poison known to science—and yet many people do not even know of its poisonous nature. To drive it home, the editor cites the fact that the authorities of the Central Park Zoo in New York chose it to liquidate a refractory elephant, which gave up the elephantine ghost after a whiff or two. (You might bear this in mind if you ever have to kill an elephant.)

The roving eye is held for an instant by a discussion of the relative merits of silver cyanide vs. silver chloride in the silver-plating solution. Some platers, it seems, make up the bath by dissolving silver chloride in potassium cyanide, because AgCl is easier to prepare than is AgCN. But the cyanide gives better results, we are told, and the chloride content of the solution is harmful—just why is not known.

One of the striking features of many articles in the journals of these years is the directions which are given for making up the various plating solutions under discussion. The electroplater of today is so accustomed to writing out a requisition for almost any chemical he desires, secure in the knowledge that he can have anywhere from an ounce to a ton delivered to him on short notice, that he would be pulled up short by the necessity of being his own manufacturing chemist—but that is precisely what his colleague of 1904 had to be. An example has already been given of the fact that platers were expected to prepare their own silver cyanide. Here's another, from an article on brass plating: copper sulfate is dissolved in water and a solution of sodium carbonate added. The resulting precipitate of copper carbonate is washed—explicit directions are given for the mixing and washing—and stirred into a solution of potassium cyanide. Zinc carbonate is prepared in an analogous manner, and similarly mixed with a KCN solution. Aqua ammonia is then added and the two solutions mixed. Anodes are of brass; and a freshly made solution, we are warned, will require coaxing.

Items: the use of a little boracic acid will improve the performance of a nickel solution. Pure iron has been produced electrolytically, it is reported.

A long article will be of interest to the wishing to make the so-called silver-depo work, for full directions are offered. (There nothing new under the sun: if that was plating on non-conductors my name is George Spelvin.*)

A further touch of modernity is lent t journal of forty-two years ago by a rep that copper has been successfully plated 1000 amperes per square foot. The solutio employed was copper nitrate plus ammoniu chloride.

A feature article discusses an inexpensi French-gray finish, to replace the immersi deposition of platinum, which was co sidered too expensive for some uses. T can be used instead of platinum: the wo is first silver-plated in the cyanide bat then brushed or buffed, cleaned, and im mersed in the following solution: water gallon, muriate of tin 2 oz., sal ammonia 1 lb. Enough sulfuric acid is added to clea up the solution. Anodes are of pure tin A "strong" current is applied, and when sufficient tin has deposited the work is rinsed and lightly buffed.

A recipe for a "quickening" solution, o "blue dip" appears. Its purpose is to de posit a trace of mercury on the work be fore silver-plating; better conductivity an prevention of oxide film are claimed. The solution is mercuric oxide in cyanide.

Turning back to the national scene for a moment, we find the political conventions in full swing. The Socialists nominated the perennial Eugene V. Debs for President; the Socialist Labor Party selected as their standard-bearer one Corregan; the Popu lists conferred this honor upon T. E. Wat son; the Republicans went along with TR by acclamation and without a contest; the Democrats called upon Alton B. Parker, and something called the Continental Party also had a ticket in the field. Best of all, though, the Prohibition Party nominated for President a man with the wonderful name of Silas Swallow (no kidding). Re

Part I appeared in the November 1945 issue of Metal Finishing.

* It isn't.

search would probably reveal that the press of the day made the appropriate comments.

The platers were concerned with more serious matters, and it may be assumed that then, as now, they were not ardent Prohibitionists. They aired their troubles in the correspondence columns of the technical press, and surprisingly often the editors had sound advice to give them. One was having trouble with his copper solution. He used commercial copper carbonate, dissolved in potassium cyanide. Each day a little cyanide was added, but after some time the deposit turned dark, although the edges were satisfactory. Addition of copper carbonate or KCN did no good. The antidote for his difficulties is threefold, according to the editors: first, don't use commercial copper carbonate (another example of the then state of the chemical industry); second, too much copper and KCN has increased the density of the solution beyond the capacity of the dynamo, as shown by the fact that the high-curent-density edges are all right—ergo use more current or dilute the solution; and finally, a little white arsenic will improve the result.

The literature of the year was studded with short articles on the nickel anode problem. A typical editorial on the subject compared cast and rolled anodes, to the detriment of the latter. It was claimed that the cast anodes, being less pure, corroded better—a feature which apparently made nickel unique among metals (?)—although it is admitted that opinion on this point is conflicting. One maker of nickel anodes deliberately added about 4% of tin; another used old files as an alloying constituent, claiming that the carbon content was beneficial.

Continuing the discussion of the nickel problem, a feature article considers "The Management of Nickel Plating Baths." A principal precaution, warns the author, is to procure only pure and neutral ammonium sulfate for making up the solution. (Incidentally, we wrote here again a commentary on the state of the chemical industry of the day in the almost universal warnings against impure and adulterated chemicals.) The operator must insure that the bath is kept neutral at all times and prevent the presence of any trace of organic material. Soft or cast nickel anodes are preferred to rolled, because the latter cause the bath to become acid due to inferior corrosion characteristics.

Reference has already been made to Edison's new nickel plating process*. A fuller description has now become available, and it appears that the process deals with plating of continuous coils. (Did anyone think that continuous strip plating was something new?) The sheet iron passed over the under rollers through a hydrogen furnace, then through the plating bath, with nickel anodes between the passes of strip, and finally into an annealing furnace and the recoil mechanism. The whole description has quite a modern ring.

Typical of the correspondence columns, here's a snappy question and answer: *Q.* I have trouble with a brass solution, the work comes out stained. *A.* Provide better rinsing. Another: *Q.* How can I plate on Britannia Metal? *A.* This metal is difficult to plate, but try transferring directly from the caustic potash cleaning bath to the plating tank without rinsing.

As typical of a series of similar questions, we select one dealing with the cause of pinholes when plating on cast iron. The editors answer that this phenomenon is caused by the rinse entering the minute holes and later working out through the plate; there seems to be no sure cure but soaking in a bicarbonate solution after the acid pickle has helped in some cases.

This item might be headed "Quick Results": a vein of copper ore has been discovered under the buildings of Columbia University; this happened shortly after Adolph Lewisohn of the Amalgamated Copper Co. gave $250,000 to the University for a new mining building.

It is pleasant to observe the plater of 1904 being praised instead of scolded—as you remember he was rather regularly the previous year—and so it seems worth quoting: "There can be no doubt that the art of electroplating is gradually advancing from a business largely carried out by rule of thumb to one where the scientific principles underlying the operations are more clearly understood, at least among the more progressive men in the plating business. The increasing use of electric measuring instruments, such as voltmeters and amperemeters among platers is convincing proof."

As if to offset that, the next item which catches our eye is from the correspondence column: *Q.* Can you give methods for determining copper, tin, zinc and lead in brass? *A.* This process is purely a chemical one and cannot be described in our journal in a way which the reader would understand. (Ouch!)

If you think that the former questioner didn't deserve such a brush-off, here's one who probably did: *Q.* I have trouble with my black nickel solution. The bath contains 1 gallon water, 1 lb. white arsenic, 1 lb. cyanide, and lead anodes. *A.* You have an arsenic-plating bath, and the deposit turns gray because it converts to arsenious oxide. It can't be a black nickel solution because there apparently isn't any nickel in it. (The editor might have added, but didn't, get the lead out.)

It is a great temptation to quote at length from a feature article on Modern Plating installations. It was apparently written in German and translated, either by the author or an editorial assistant—in any case, with an axe. Quote: "*With the increase in the capacity of electrolytic dynamos, the electroplating methods were led into different channels, so that today we find large establishments which can stand comparison with any other branch of manufacturing in regard to extent as well as rentability. Probably in few fields so much has been sinned than has been done in the electroplating business . . . . . Installations have often been made the view of which fills the expert with more than wonder . . . . In the foreground of interest stands for some time the electrogalvanizing of iron, and the installations for that purpose are pushing out the old methods of galvanizing, as far as size and rentability are concerned. It is a pity, that on account of the unbusinesslike proceeding of such electrogalvanizing establishments this method has been brought into discredit . . . I can only say that electrogalvanizing is at least equal if not preferable to hot galvanizing, but the manufacturers should not want to make more money than can be legitimately made already. It must not be believed that iron is proof against rust if it only shows the color of zinc . . . The principal mistake is made by endeavoring to be economical with the zinc and taking layers of less than* 0.0000394 *inch thickness as the normal ones as being rust-proof.*"

A new process for electrolytic stripping of brass brazing from bicycle frames utilizes a sodium nitrate solution; it is based on the fact that the iron becomes passive in this solution, while copper and zinc are anodically dissolved.

Item: ship-bottoms electroplated with copper have been the cause of some legal actions: steel bottoms lying in the same harbors have been corroded due to the galvanic couples set up.

Here's an interesting, if somewhat impractical, suggestion: investigators should introduce some system into methods of discovering means of electrodepositing metals. For example, if it is desired to develop a zinc-plating bath, one should begin with copper; proceed to arsenic, bismuth, through tin, lead, cobalt, iron, thallium and cadmium to zinc. The point is that each succeeding metal is, according to the electromotive series, slightly more difficult to deposit than the one before it, so we proceed by easy stages and with unfailing logic to our goal.

Two articles dealt with electroplating on aluminum, and the suggested techniques sound surprisingly modern. The formation of anodic films on aluminum was also under investigation, although the word "anodizing" was not used.

The year 1904 also marked the promulgation of Dr. Bancroft's well-known axioms of electrodeposition, which called forth much discussion in the technical press. They are too long to quote here; but in some respects these axioms and the discussions which they inspired may be taken as marking the beginning of the modern era in electroplating practice.

We may bid farewell to the journals of the year by recalling that on November 8 the American people preferred the Rough Rider to Mr. Parker by about 7,500,000 to 5,000,000. The aptronymic Mr. Swallow also ran with 250,000 votes. Victorious TR immediately announced that under no circumstances would he be a candidate for a third term.

It should be restated that these rather flippant reviews have taken little or no notice of the average, serious, unexceptionable articles and papers which formed the great bulk of the editorial matter in the technical and scientific press. On the contrary, the attempt has been made to select those items which would amuse rather than instruct the modern reader. The author can only apologize to the journals and their editors for the unavoidable injustice done them.

I'll be back in 1905, with more late news.

* See previous installment.

THE HOW AND WHY OF A TANK RHEOSTAT

By H. W. SUSSMAN

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A TANK rheostat is a device for regulating the current flow in a plating bath by controlling the impressed voltage across the bath proper. Inherently, then, it is a voltage drop device.

Before one can understand the operation of the rheostat he must understand the basic law governing D.C. electrical circuits. This law is known as Ohm's law and is expressed in the form of:

(1) $$E = IR$$

Where: E is the impressed voltage
I is the current in amperes
R is the resistance in ohms

Equation (1) can also be expressed as follows:

(2) $$I = \frac{E}{R} \qquad \text{Current} = \frac{\text{Voltage}}{\text{Resistance}}$$

or (3) $$R = \frac{E}{I} \qquad \text{Resistance} = \frac{\text{Voltage}}{\text{Current}}$$

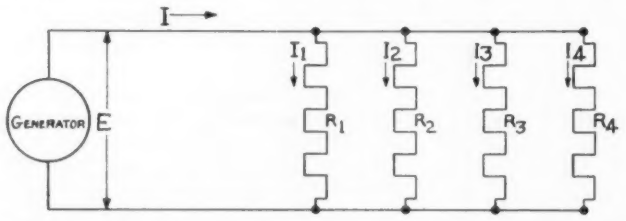
Since most rheostats for plating are of parallel resistor design there is one additional equation which one must understand and that equation governs the equivalent resistance of resistors in parallel and is expressed as follows:

(4) $$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} \text{ etc.}$$

Where R = Equivalent resistance and R_1, R_2, R_3, and R_4 are the resistors in parallel. Transposing

(5) R the equivalent resistance $$= \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} \text{ etc.}}$$

The proof of equation (5) is quite simple. Consider the following circuit:



With a given impressed voltage (E), the current flowing through resistor R_1 is:

(6) $$I_1 = \frac{E}{R_1}$$

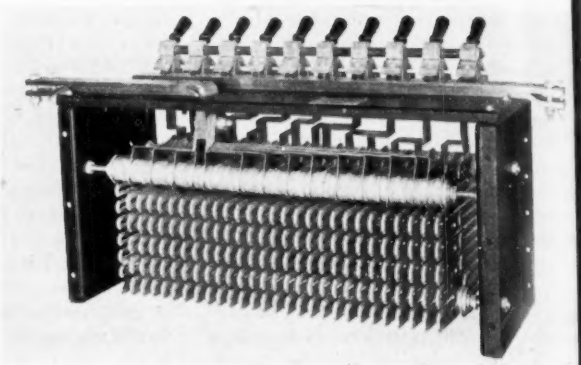
Similarly the currents flowing through R_2, R_3 and R_4 are:

(7) $$I_2 = \frac{E}{R_2}$$

(8) $$I_3 = \frac{E}{R_3}$$

(9) $$I_4 = \frac{E}{R_4}$$

It will be noted that the same voltage is impressed across all four



Bottom view of 2000 ampere, 3 volt drop rheostat showing arrangement of grids and internal bussing.

resistors and obviously the total current flowing from the generator is the sum of I_1, I_2, I_3 and I_4. Therefore,

(10) $$I \text{ Total} = I_1 + I_2 + I_3 + I_4.$$

The equivalent resistance is that value of resistance which would permit the same total current flow if the four resistors were replaced by one resistor or:

(11) $$I_T = \frac{E}{R_E}$$

Substituting in equation (10) the values of I_1, I_2, I_3 and I_4 from equations (6), (7), (8), (9) and (11) we have:

(12) $$\frac{E}{R_E} = \frac{E}{R_1} + \frac{E}{R_2} + \frac{E}{R_3} + \frac{E}{R_4}$$

The factor of E is common to all terms of this equation so if we divide both sides of equation (12) by E we have equation (4)

$$\frac{1}{R_E} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$

Similarly it can be shown that when two or more resistors are in series the equivalent resistance is the sum of the two individual resistors. Expressed mathematically:

$$R_E = R_1 + R_2 + R_3, \text{ etc.}$$

Let us take a typical plating bath and see just what happens in terms of Ohm's law, with a fixed line voltage.

The factor of R in Ohm's law (as applicable to a plating bath) is governed by the amount of anode and cathode polarization and decomposition potential as well as the conductivity of the bath and the distance between anode and cathode. Obviously the larger the piece of work in a given bath the greater the polarization.

With a fixed distance between anode and cathode and a fixed conductivity let us assume that we have a piece of work in the bath which requires 10 amperes plating current. Substituting in equation (1), we have:

$$E = 10R$$

assuming that R of the solution is equal to 0.3 ohm we have:

$$E = 3 \text{ Volts.}$$

Now if the line voltage is six volts this means that 3 volts will have to be dropped to obtain the proper plating current in the bath.

In order to dissipate the extra 3 volts a resistor is inserted in series with the tank and the line so that the resistance (R) of the tank and the series resistance will result in a voltage drop of six volts. Substituting equation (1), we have:

$$6 = 10R.$$

Where: E is the line voltage (6 volts)
I is 10 amperes
R is the sum of the resistance of the tank (R_1) and the resistance of the resistor (R_2).

Ohm's law for this circuit then becomes:

(13)
$$E = I\ (R_1 + R_2)$$
$$E = 10\ (R_1 + R_2)$$
$$6 = 10\ (0.3 + R_2)$$
$$6 = 3.0 + 10R_2$$
$$3 = 10R_2$$
$$0.3 \text{ Ohms} = R_2.$$

It can be readily seen that the value of the external resistance in this circuit becomes equal to the tank resistance.

Now if the initial piece of work is removed and a piece of work is inserted in the bath which changes the effective bath resistance to 0.6 ohms and which requires 5 amperes for a good plate, let us see what will happen with the same external resistance in series with the bath. Substituting in equation (13), we have:

$$6 = I\ (R_E + R_B).$$

Where: R_E is External Resistance
R_B is Bath Resistance

$$R_E = 0.3$$
$$6 = I\ (0.3 + 0.6)$$
$$\frac{6}{0.9} = I$$
$$I = 6.67$$

Under this condition 6.67 amperes will flow in the bath, which will obviously burn the work.

Since we know that for a good plate, 3 volts are required across the work why then do we have 6.67 amperes flowing through the tank? Substituting in equation (13), we see that the 6-volt line is now composed of two parts, namely, the voltage drops IR_E and IR_B. Substituting the values of I, R_E and R_B in equation (13), we have:

$$6 = 6.67 \times 0.3 + 6.67 \times 0.6$$
$$6 = 2.0 + 4.0.$$

Where: IR_E is Voltage drop through the rheostat
IR_B is Voltage drop across the tank.

Obviously if there are 4.0 volts impressed on a bath where only 3 volts are required too much current will flow and in this case we have 6.67 amperes in the bath where only 5 amperes are required.

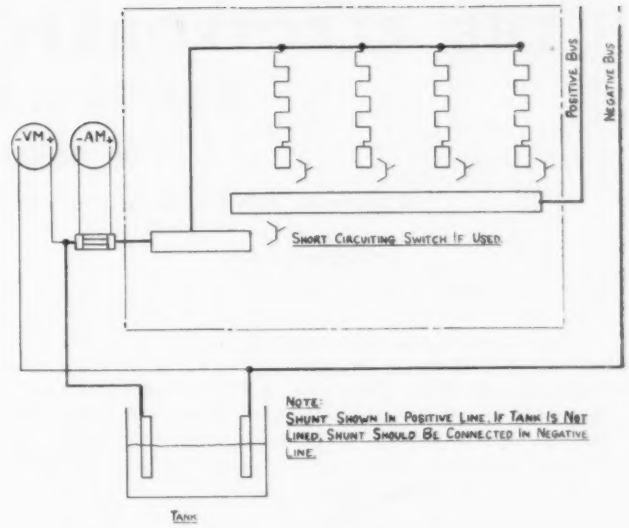
This then explains why quite often the resultant current obtained from a given switch setting on a rheostat does not correspond with the ampere marking of the switch. This marking is really an indication of the current required to flow through the switch in order to obtain the rated voltage drop of the rheostat for that switch setting. It does not indicate that by closing the switch one will automatically obtain the current flow as marked on the switch at the voltage drop rating of the rheostat unless the factors of the rest of the circuit are right (i. e., the effective bath resistance).

How then are we going to regulate the current to avoid burning the work? The answer to this lies in the skill of the operator in utilizing his rheostat. So far we have only considered one switch of a rheostat; let us consider a typical 150 ampere, 3 volt drop rheostat of the parallel resistor type.

This rheostat has 5 steps rated 5, 10, 20, 40 and 80 amperes at 3 volt drop. Since this is a 3 volt drop unit the following resistance values apply to the various switches:

Step 1 = 0.6 ohms.
Step 2 = 0.3 ohms.
Step 3 = 0.15 ohms.
Step 4 = 0.075 ohms.
Step 5 = 0.0375 ohms.

If, on starting the work, the operator first throws in the switch of lowest ampere rating, he can then build up to the desired current. For example, consider a piece requiring 15 amperes. On the



assumption that the equivalent bath resistance is now 0.2 ohms $\left(= \frac{3 \text{ Volts}}{15 \text{ Amperes}}\right)$ we will have with switch No. 1 in the circuit a current of:

$$6 = I\ (0.6 + 0.2) \text{ (from equation 13)}$$
$$\frac{6}{0.8} = I$$
$$I = 7.5 \text{ amperes.}$$

You will note that this is actually 50% more current than step No. 1 is designed to handle and is only half of the desired current. A well designed rheostat takes this operating condition into consideration and allows extra capacity in the grid elements for overload conditions. We still require an additional 7.5 amperes on the work to arrive at the proper plating current. With switch No. 1 closed we close switch No. 2 (marked 10 amperes). From equation (4) the equivalent resistance of step No. 1 and step No. 2 in parallel (both switches closed) is:

$$\frac{1}{R_E} = \frac{1}{R_1} + \frac{1}{R_2}$$

Solving for R_E we have:

$$R_E = \frac{1}{\frac{1}{0.6} + \frac{1}{0.3}} = 0.2 \text{ ohms.}$$

(Substituting in equation (13)):

$$6 = I\ (R_E + R_B)$$
$$6 = I\ (0.2 + 0.2)$$
$$6 = 0.4$$
$$I = 15 \text{ amperes.}$$

It will be noted that this is the sum of the currents of steps No. 1 and No. 2. Under this operating condition the first step is no longer overloaded since it has 5 amperes flowing through it and step No. 2 has 10 amperes flowing through it.

It can likewise be shown that, as the amount of work in the bath is increased, the desired amount of current can be obtained by the proper combination of switches.

It is not necessary for the operator to concern himself with Ohm's law in operating a rheostat because he has a voltmeter and ammeter to guide him. Generally, the operator knows that he requires a certain current in his tank at a given tank voltage to obtain the desired plate. Under ideal conditions he should be able to adjust his rheostat until he obtains the desired tank voltage and automatically obtain the proper tank current. Practically, it is not possible to do this because the suspending wires or racks, the anode and cathode rods may not be of sufficient cross section to carry the current without appreciable voltage drop or the anode surface may polarize. Control by voltage alone is not good practice and should be avoided.

(*Concluded on page* 148)

THE ELECTRODEPOSITION OF COPPER

A Review of Recent Literature

By HERBERT BANDES

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Introduction

THIS review contains a critical evaluation of the recent work done in the field of electrodeposition of copper. It will be noted that there are few references in this report to work prior to 1932, primarily because modern copper plating practice is based on work published after that date. The review by Bennett,[1] which covers the period up to 1913, indicates the poor state of the art prior to that date.

There are three major types of solutions available for copper plating (although the third is not at present in commercial use) as follows:

a. Acid solutions of copper salts.
b. Alkaline solutions of copper salts.
c. Solution of a copper salt in a fused electrolyte.

The recent literature, in so far as it treats some fourteen individual examples of the foregoing classes, will be discussed as well as the metallurgical nature of the electrodeposited copper.

I. Acid Solutions

The "Acid-Copper" Solution

On a tonnage basis, the "acid-copper solution" is the most important of all copper plating solutions in that it is used not only for electroplating but also for electrolytic copper refining, production of copper electrotypes and electroforming. The solution formula[2] follows: $CuSO_4.5H_2O$, 150 to 250 g./L.; H_2SO_4 45 to 100 g./L.

The solution is commercially operated at a temperature of 22° to 55° C. (70° to 131° F.) and at a cathode current density of 25 to 60 amp./sq. ft. (2.7 to 6.5 amp./dm.²). Addition agents (among which are gelatin, gums and other carbohydrates, urea, thiourea and phenolsulfonic acids) refine the grain size of the deposit. However, it is seldom that addition agents help to give mirror-bright copper deposits. A notable exception is the solution of Clifton and Phillips[3] containing thiourea as an addition agent and Triton No. 720* as a wetting agent. Another formulation[3] of the acid-copper bath, containing molasses and thiourea as addition agents, gives bright deposits at current densities as high as 75 amp./sq. ft. (8.1 amp./dm.²).

The effect of ferrous ions in the acid-copper plating solutions has been studied by Adamovich[4] who claims that current densities as high as 280 amp./sq. ft. (30 amp./dm.²) can be used in solutions which contain 20 g./L. of ferrous ion.

Acid-copper solutions have been discussed recently by Pierce[5] and by Adler and Krinowitz[6] in connection with the plating of copper on steel wire prior to drawing. These authors plated copper alternately from a cyanide bath and an acid bath in order to control grain size. Their acid-copper solution was: $CuSO_4.5H_2O$, 220 to 240 g./L.; H_2SO_4, 75 g./L.

Bath temperature, 46° C. (110° F.).

Cathode current density, 225 amp./sq. ft. (24.5 amp./dm.²).

Agitation (by air), violent.

The advantages of the acid-copper solution are: a. low cost; b. simplicity and ease of operation; c. high current efficiencies (95 to 99% both at anode and cathode).

The disadvantages of this type of solution are: d. large grain size of electrodeposited metal; e. poor "throwing power," *i. e.*, inability to give a deposit of uniform thickness on complex surfaces; f. copper is deposited from the divalent ion—necessitating the use of two Faradays of electricity per gram atomic weight deposited; g. deposit is not bright in the absence of addition agents; h. cannot usually deposit directly on iron or steel.

It will be pointed out below that grain size is reduced and the tendency to deposit equi-axed crystals is enhanced as current density in the acid-copper solution is increased. The work of Pierce[5] and of Adler and Krinowitz[6] indicates that agitation permits use of high current densities. In fact, Winkler[2] states that a current dens... high as 3,000 amp./sq. ft. (320 amp./dm.²) has been used in de... ing copper from an acid-copper solution on fast moving steel ... and on rapidly rotating cathodes. Little work has been publ... with respect to the grain structure of copper deposited at ... extremely high current densities.

Hull has recently disclosed the use of from 0.1 to 9.1 g./L. (... to 1.5 oz./gal.) of cuprous cyanide in an acid-copper plating solu...

Cuprous Copper Solution

The use of an acid solution containing cuprous copper would ... come the objection raised previously, *i. e.*, the usual acid-co... solution calls for the use of two Faradays of electricity per gram ... of copper deposited. Two such acid solutions, where deposi... from monovalent copper, have been described recently: (*a*) cu... chloride: Diev and Loshkarev[8]; (*b*) cuprous chloride-sodium ... sulfate: Gernes, Lorenz and Montillon[9]. Both solutions are ... acterized by rather low current densities (about 40 amp./sq. ft. ... amp./dm.²) for solution (*a*), and 20 amp./sq. ft. (2.1 amp./d... for solution (*b*). Special precautions must be taken to pr... chemical stability of the cuprous ions or the thiosulfate-copper ... plex; a film of paraffin oil on the solution surface to minimize o... tion by air is recommended by Diev and Loshkarev while Gernes ... co-workers use 10 g./L. of sodium bisulfite. Both cuprous solu... however, are reported to give bright deposits of copper.

Solution of the Copper Salt of Benzenedisulfonic Acid

A recent patent by Stack[10] discloses the use of an aqueous sol... of the copper salt of benzenedisulfonic acid for use in copper pla... This solution operates at a maximum current density of 25 a... sq. ft. (2.7 amp./dm.²) and at a temperature of 72° C. (160° F.) ... permits the electrolytic separation of copper from a variety of ... metals. The patent is not explicit with respect to current efficie... or the physical nature of the deposits.

Solutions of Complexes of Copper and Dibasic Organic Acids

The ability of dibasic organic acids, such as tartaric, lactic, ci... oxalic, succinic and malic acids, to form complexes with copper ... been exploited principally in the Rochelle salt baths to be discus... below. Little work, however, has been published on solutions ... taining the other possible complexes of copper with dibasic org... acids. Fink and Wong[11] recommended the use of the oxalate-cop... complex for "striking" steel with copper prior to plating in the a... copper solution. Their solution formula is: $CuSO_4.5H_2O$, 16 g./... $Na_2C_2O_4$, 17 g./L.; Na_2SO_4, 6 g./L.; H_3BO_3, 20 g./L.

Temperature, 20° C.

C. D. 10 amp./sq. ft. (1.1 amp./dm.²).

At higher current densities, or for plating time much in excess ... 60 sec., the deposit, particularly around the edges, is dark. S... recent work published in German[12] and in Russian[13, 14, 15] publ... tions at present inaccessible to the writer) discuss such solutio... The abstract of the German patent[12] is very short and contains li... useful information. The abstract of the Russian patent[13] indica... that a copper lactate complex is electrolyzed at about 14 amp./sq. ... (1.5 amp./dm.²).

The abstracts of the work by the Russian, Levin, and co-worker... and Levin[15] are more complete. These recommend a solution ... follows: $CuSO_4.5H_2O$, 12 g./L.; sodium oxalate, 25 g./L.; amm... nium hydroxide (28%), 27 g./L. When used at 25° to 30° C. (7... to 86° F.) and at a current density of 100 to 150 amp./sq. ft. (1... to 16.2 amp./dm.²) a malleable, dense, shiny copper deposit ... obtained from a solution aged for several days (a fresh solution yi... brittle deposits). The reported cathode current efficiency is abo... 120% which suggests that considerable copper is being deposite... from the cuprous state.

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* Triton, a trinitrotoluene product.

[1] See Bibliography at end of paper.

TABLE I

Formulas of Cuprocyanide Plating Solutions

Author	Ref.	CuCN g./L.	CuCN moles/L.	NaCN (Total) g./L.	NaCN (Total) moles/L.	NaCN (Free) g./L.	NaCN (Free) moles/L.	Na_2CO_3 g./L.	Other g./L.	pH‡	Temp. ° C.	CD Amp./ft.²	Moles NaCN / Moles CuCN
Pierce, R.	5	68	0.75	100	2.10	25	0.51	"as desired"	none	**	65	30	2.80
Adler & Krinowitz	6	68	0.75	100	2.10	25	0.51	none	none	**	65	30	2.80
Blum & Hogaboom	18	22.5	0.25	34	0.69	9	0.18	15	*Hypo 2	**	under 40	3–15	2.75
Pinner & Baker	19	30	0.33	45	0.92	12	0.25	11	*Hypo 0.6	**	49	24	2.79
Pan, L. C.	20	90	1.00	106	2.16	8	0.16	78	none	**	22	20	2.16
Phillips & Meyer	21	25	0.28	35	0.71	8	0.16	5	NaOH 15 Pb 0.01 0.1	**	38	10–20	2.53
Young & Reid	22	90	1.00	105	2.16	7	0.14	78	none	11.	21	20	2.16
Caldwell, M. R.	23	19	0.21	25	0.51	4.5	0.09	none	Pb	12.6	65–76	60–79	2.42
Dowm, E. C.	24	50	0.55	80	1.63	25	0.51	10	*Hypo 5	**	Warm	30	2.96

* Brightener ($Na_2S_2O_3 \cdot 5H_2O$).
** Not specified by original author.
‡ Colorimetric.

II. *Alkaline Solutions*

A considerable degree of activity has been shown in the investigation of copper plating solutions of pH greater than 7. This activity is reflected in the patent literature, as well as in papers of a theoretical nature and in reports of a more practical kind. Four entirely different alkaline copper plating solutions have been patented within the past five years. These developments, as well as recent work done on the classic cuprocyanide solution, will now be discussed.

Cuprocyanide Solutions*

Solutions which contain the cuprocyanide radical are used in electroplating (as distinguished from electroforming and electrorefining) probably more extensively than those of any other type. Recent developments have made this type of solution extremely efficient and easy to operate. Furthermore, bright deposits may be obtained therefrom.

The classic cuprocyanide solutions are characterized by a wide range of formulas, as shown in Table I. Note that the copper cyanide concentrations range from 0.2 to 1.0 *M* (19 to 90 g./L.) and that molar ratios of sodium cyanide to copper cyanide cover the range 2.16 to 2.96. The highest value of current density given in Table I is for a solution operating at the highest temperature and at a NaCN/CuCN ratio lower than that reported by most workers. (Caldwell.[23]) Further, this solution is not made up with sodium carbonate. However, a definite pH, 12.6 to 12.8 (colorimetric) is specified. It will appear later that these conditions typify the recent developments in depositing copper from the cyanide solution.

The anode and cathode current efficiencies in the classic cuprocyanide solutions are low and variable—values from 30% to 90% have been reported, depending upon the operating conditions. In their study of this plating bath, carried out at a temperature of 22° C. (70° F.) and at a colorimetric pH of 11, Young and Reid[22] note that the anode and cathode current efficiencies decrease as: (a) pH is raised; (b) current density is increased; (c) temperature is increased.

Graham and Read[20] had previously found that aqueous sodium carbonate solutions and sodium cyanide solutions at room temperature are resistant to pH change, *i. e.*, are buffered, over the pH range 11.3 to 11.9 (colorimetric).

The work of Young and Reid was a continuation of the work of Pan[20] who found at 22° C. (72° F.) that (a) cathode current efficiency decreases with an increase in free cyanide concentration; (b) anode current efficiency increases with an increase in free cyanide concentration; (c) at comparable current densities the cathodic current efficiencies in 1 *M* cuprocyanide solutions are about 35% higher than they are in 0.22 *M* solutions; (d) an increase in carbonate concentration reduces anodic polarization when anode current densities are lower than 13 amp./sq. ft. (1.4 amp./dm.²).

Unfortunately, the work of both Pan and Young and Reid is of limited applicability because of its having been done at the low temperature of 20° C. (72° F.). It is well known that the equilibrium constants of complexes containing the cyanide radical, CN–, are dependent upon temperature.[17] In view of this temperature dependence, it is very likely that deposition potentials (and polarization potentials, too) will depend upon temperature. Therefore, the extrapolation of the findings of these three workers to higher temperatures might lead to serious error. A further source of error in extrapolating to higher temperature lies in the relationship between diffusion processes and polarization potential, anode and cathode efficiencies and limiting current density.[16, 25, 26] Note that the rate of diffusion increases at a rate of about 2% per 1° C. increase in temperature.[27] However, despite the low temperatures used in their work, the findings of Pan and of Young and Reid are of value in stimulating further work on the cuprocyanide solution.

Rochelle Salt-Cyanide Solutions

The sodium cuprocyanide solutions previously discussed give satisfactory deposits of copper when used at the proper low current densities. At the anode, however, the variations in current efficiency are very considerable and under the most adverse conditions fall to almost zero. In an attempt to eliminate this erratic behavior, McCullough and Gilchrist[28] recommended the use of rochelle salt (potassium-sodium tartrate) in the cuprocyanide plating solution.

Graham and Read, in a series of six papers, discuss the chemistry of the rochelle salt-cyanide copper solution.[29] Since much of their work is summarized in their recent review paper,[30] it need not be discussed at length.

The work of Graham and Read has indicated that, as solution temperature increases, current efficiency increases (current density held constant). However, these workers recommend a rather low metal concentration. Nevertheless, the trend toward higher metal concentrations, probably influenced by Pan's work[20] (see also Table I) on the cuprocyanide solution, had already started. Thus, Hirsch[31] and Wagner and Beckwith[32] recommended higher copper cyanide concentrations than do Graham and Read. Hirsch,[31] however, advocates the use of an extremely low cathode current density in order to get maximum current efficiency. He also finds that sodium carbonate or rochelle salt increases the cathode efficiency. Smith and Munton[33] corroborate Graham and Read with respect to the

* The exact nature of the copper-cyande complex in cuprocyanide plating solutions is still uncertain. However, for the purposes of this review, the complex will be assumed to be $[Cu(CN)_3]^=$ as assumed by Petrocelli[16] and by Thompson.[17]

TABLE II

Formulas of Rochelle Salt—Cuprocyanide Plating Solutions

Author	Ref.	CuCN g./L.	CuCN m./L.	NaCN (Total) g./L.	NaCN (Total) m./L.	NaCN (Free) g./L.	NaCN (Free) m./L.	Rochelle Na_2CO_3 g./L.	Rochelle Salt g./L.	Temp. ° C.	Current Density An. Amp./ft.²	Current Density Cath. Amp./ft.²	Curr. Eff. % An.	Curr. Eff. % Cath.	Molar Ratio NaCN/CuCN
Graham & Read	29	26.5	0.30	35.5	0.72	5.6	0.11	30	60	70	30	60	—	43	2.40
Hirsch	31	45	0.50	65	1.33	15	0.31	45	45	55	**	3.8	—	95	2.66
Smith & Munton	33	20.5	0.23	28	0.57	5.5	0.11	15	30	65	**	50	—	53	2.48
Bakhalov	36	40	0.45	50	1.02	6	0.12	30	60	60	15	25	75	75	2.27
Jelinik	38	28	0.26	46	0.94	15	0.31	**	50	50	19	56	50	50	3.61

** Not specified by original author.

need for an elevated temperature and a low cyanide/metal ratio. They found that at 65° C. (150° F.) and a cathode current density of 50 amp./sq. ft. (5.9 amp./dm.²) the cathode efficiency is reduced from 52.8 to 45.2% if sodium citrate is substituted for rochelle salt. However, they observed that the citrate ion leads to a brighter deposit, a more uniform color and grain size and a lesser tendency toward roughness and "burning," *i. e.*, a higher maximum usable current density. They also report that the cathode current efficiency in the citrate bath increases as the sodium ion is replaced by the potassium ion. The beneficial effect of the potassium ion on the nature of the deposit is discussed by Stoddard[34] who states, "the lightening of the color of the cathode deposit together with the tendency of this deposit to become brighter, can be noticed, in increasing degree, as the potassium ion concentration of the solution exceeds 0.3 *N*, regardless of the form in which the potassium ion was added to the solution." Graham,[35] however, states, "I am not convinced that the potassium ions give the same beneficial effect as that noted with rochelle salt." The conclusions of Graham and Read[29] are confirmed by Wagner and Beckwith.[32]

The specific action of the tartrate radical in the rochelle salt-cuprocyanide solution is discussed by Bakhalov[36] who believes that, in reducing the rate of anodic oxidation of the cyanide radical, the tartrate radical permits the use of higher anode current densities.

Maher[37] recommends the use of pH 9.6 (colorimetric) or lower in order to reduce blistering when copper-plated zinc castings are baked after the application of organic finishes. In order to counteract the tendency of the deposit to be colored brick red, sodium thiosulfate (about 0.9 g./L.) must be used.

Jelinik[38] and Graham,[39] in review papers, further discuss the rochelle salt-cuprocyanide plating bath. The specific solutions recommended by the various authors cited are shown in Table II.

The du Pont High Speed Solution

By a judicious application of the principles discussed previously relating to the cuprocyanide and the rochelle salt-cuprocyanide solutions and to the proper choice of addition agents, it is possible to deposit copper in the lustrous condition at a current density of 100 amp./sq. ft. (10.8 amp./dm.²) and a cathode current efficiency of 95% to 100% from a solution of univalent copper. These developments were worked out by the du Pont Company and are covered by patents,[40, 41, 42] and have been discussed in the technical literature.[43, 44]

The preferred formula for the du Pont bath is: copper cyanide 120 g./L.; sodium cyanide (total), 135 g./L.; sodium cyanide (free) 3.75 g./L.; sodium hydroxide, 30 g./L. Or: potassium hydroxide 42 g./L.; brightener (NaCNS), 15 g./L.; anti-pitting agent, 1.5 g./L.

The solution is operated hot (70° to 80° C.) (156° to 176° F.) and, if the work is agitated, at a cathode current density of 100 amp./sq. ft. (10.8 amp./dm.²) and a cathode current efficiency of about 100%. The anti-pitting agent[40] is a betaine, a cyclic amine containing one non-cyclic hydrocarbon radical of 10 to 20 carbon

TABLE III

Various Copper—Amine Electroplating Solutions

Author*	NH_4OH (25%)	Ethanolamines: Mono	Ethanolamines: Di	Ethanolamines: Tri	Ethanolamines: Tri	Ethylene Diamine	Ethylene Diamine	Diethylene Triamine	Diethylene Triamine
	K	B	B	B	S	B	H	B	G
Reference	47	48	48	48	49	48	50	48	51
Amine	500 cc.	77-151 cc.	136 g./L.	22 cc.	30 g./L.	42.5 cc	135 g./L.	35 cc.	80 cc.
$CuSO_4.5H_2O$ g./L.	65	76-149	105	15	25	50	139	50	100
$(NH_4)_2SO_4$ g./L.	20	..	..	..	..	..	..	..	20
Rochelle Salt g./L.	..	..	..	..	15	..	..	..	..
Sodium Oxalate g./L.	..	25-50	35	10	..	..	..	..	..
NH_4OH	..	..	..	..	..	..	..	..	10-30 cc.
Temp. ° C.	**	20-30	20-30	20-30	20	50	**	50	60
C. D. amp./ft.²	30	29-108	15-55	4	10	30	20-40	10	50-130
pH	**	**	**	**	7	12.3	8.8	9.4	**
Cathode Efficiency, %	**	>90	97	95	**	100	**	122#	>90
Agitation	**	**	**	**	**	**	**	**	Necessary
‡‡Condition of deposit	A B D	B	A B	B	A B	G	G	A B	A B D
Remarks	..	Narrow c.d. range	..	..	..	..	Uses H_2SO_4 8 cc./L. to adjust pH	..	Solution must be clean

* B: Brockman & co-workers
G: Greenspan
H: Hartford
K: Kudra & Kleibs
S: Schweig

** not specified by original author
‡ based on: $Cu^{++} + 2e = Cu^{\circ}$

‡‡ A: adherent
B: bright
D: ductile
G: good

ms. The betaines are reported[40] to be effective anti-pitting agents concentrations as low as 0.07 g./L. Another type of addition nt is discussed by Hull[41] who claims that the cyclic methylene er of 3, 4, dihydroxybenzaldehyde (piperonal) and analogous com-nds are useful addition agents in copper and copper alloy deposi-, particularly in conjunction with a soluble compound of Al, Ti, W, U, Mn, Re, Fe, Ni, Co or, preferably, Mo and a protective loid. The use of sodium thiocyanate as a brightener is described patent issued to Wernlund, Benner and Bair.[42] This patent also cribes the use of a carbohydrate brightener in conjunction with thiocyanate and an alkali cyanide to copper cyanide weight ratio 1.25 or less. This is equivalent, on a molar basis, to a maximum o of 2.29. With respect to the use of a sulfur-containing salt as rightener, attention is called to the use of: (a) thiourea[3] in the d-copper plating solution; (b) sodium thiosulfate[18, 24] in the rocyanide plating solution (see Table I); (c) sodium thiosulfate[37] the rochelle salt-cuprocyanide solution.

The use of high purity copper anodes at a current density of er 30 amp./sq. ft. (3.2 amp./dm.^{2}) is recommended in order to an anode current efficiency of 100%. As much as 60 g./L. of bonate, formed by absorption of CO_2 from the air, is tolerable. idation of cyanide to form carbonate appears to be very slight. e du Pont Company recommends the substitution of potassium salts sodium salts. They claim the potassium bath will permit the use even higher current densities than will the sodium solution on an uivalent basis. At substantially 100% cathode efficiency, the potas-m bath containing 52.5 to 60 g./L. (7 to 8 oz./gal.) copper cyanide claimed to give equal or better performance than the sodium bath ntaining 105 to 120 g./L. (14 to 16 oz./gal.) of copper cyanide.[45] ernlund[46] claims the use of an amount of alkali metal cyanide uivalent to a sodium cyanide to copper cyanide weight ratio of m 1:1 to 1.25:1, the alkali metal being sodium and potassium, sent in the proportion of 1 to 6 moles of sodium ions for each le of potassium ions.

LUTIONS OF COPPER AMINES

Until the development of the high speed cyanide copper plating lution, the alkaline copper plating solutions were characterized by w and erratic current efficiencies and low current densities.

All cyanide solutions, of course, are highly toxic. An attempt to viate these disadvantages of the cyanide solutions, at the same time oiding the poor throwing power of the acid solutions, was made a group of workers who investigated the complex copper amine lutions. Details of these solutions are given in Table III.

Brockman and co-workers[48] investigated the deposition of copper om solutions containing complex amines: mono-, di- and tri-thanolamine, ethylenediamine and diethylenetriamine. The use of dium oxalate with the ethanolamines was found to be necessary.

As the temperature of the diethylenetriamine solution was in-eased from 25° C. to 50° C. (78° F. to 122° F.) the cathode efficiency sed on deposition of copper from the cupric state) increased from 8% to 122%, with current density held constant.* It was also noted Brockman that the cathode efficiency decreases as the current nsity increases (temperature constant). In his discussion of this per, G. B. Hogaboom, Jr.,[52] indicates that pH control is essential. hus, when the pH is under 7, the deposit is poorly adherent; when e pH exceeds 9, the deposit is powdery.

Harford[50] has disclosed a solution based on ethylene diamine hich is operated at a pH of 8.8. See Table III for further details one of the solutions described in this patent.

Several of the more recent papers (work done by Russian and rman authors) were not available to us. Therefore references to ese works will be confined to the accounts given in Chemical bstracts.

The use of the chloride ion (10 g./L. of HCl or 30 g./L. of hloride) to reduce the brittleness of copper deposited from an mmoniacal solution was patented by Tagil'tsev.[53]

A triethanolamine solution, reputed to give adherent, bright de-osits, was patented by Schweig.[49]

An ammoniacal solution of cuprous and cupric ions (with the cuprous in excess) in a solution containing about 20 to 25 g./L. of free ammonia has been patented by G. Hausel.[54] This solution is said to give good deposits at current densities under 25 amp./sq. ft. (2.7 amp./dm.^{2}). The use of an alkaline bath containing cyanides, ammonium salts or amides and nitrosubstituted organic compounds is the subject of a patent for reclaiming copper from copper-coated scrap iron.[55]

Copper may be deposited directly on iron, aluminum and duralumin from a solution described by Kudra and Kleibs.[47] Their solution is claimed to give dense, bright, adherent deposits that are ductile.

A solution based on diethylene triamine which will yield bright, ductile deposits at 50 amp./sq. ft. (5.4 amp./dm.^{2}) and at 130 amp./sq. ft. (14 amp./dm.^{2}) for simple shapes has been described by Greenspan.[51] Deposition is carried on in an air-agitated solution and at current efficiencies which exceed 90%. The contention is made by Greenspan that Brockman's diethylene triamine copper solution[48] gives brittle deposits, but that addition of ammonium sulfate leads to ductile deposits. The importance of solution agitation is indicated by the fact that 10 to 30 cc./L. of 28% NH_4OH are to be added if the work alone is agitated. A clean, well purified solution will not give pitted deposits. However, if the solution is not clean and pure, pits may be eliminated by the addition of 2 cc./L. of "tergitol 08," a wetting agent, or by the addition of ammonium hydroxide. The ammonium sulfate is believed to act as a buffer by virtue of the reaction:

$$(NH_4)_2SO_4 = 2\ NH_3 + H_2SO_4$$

The need for a buffer in this type of solution had been recognized earlier by Hogaboom.[52] Note that, as the rate of agitation increases, the quantity of NH_4OH which must be added as a brightener is decreased. Further, if ethylene diamine is used instead of diethylene triamine, 50 to 100 cc./L. of 28% NH_4OH must be added to overcome brittleness. The influence of ammonia and ammonium sulfate in reducing brittleness of deposits is ascribed by Greenspan[51] to "the function (of NH_3 and $(NH_4)_2SO_4$) of preventing the deposition of basic compounds by exerting a solubility effect in the cathode film."

Iron and zinc work should be copper flash plated in a cyanide solution before plating in the diethylene triamine solution to avoid subsequent blistering.

Newton and Furman[56] claim that the tendency of copper to deposit from Cu $(NH_3)_4^{++}$ is reduced as the concentration of copper increases and as the rate of stirring increases. Their solutions, however, were as concentrated as 0.6 *M* (48 g./L.) with respect to the nitrate ion. The nitrate ion is believed by Weisberg[57] to interfere in electroplating.*

PYROPHOSPHATE SOLUTIONS

In the recent past two groups of workers have been active in the development of a copper plating solution based on the copper-pyrophosphate ($Cu(P_2O_7)$ = radical, and both groups appear to have exploited the commercial application of the bath.

The solution described by Stareck[59] and by Coyle[60] may have compositions as follows:

SODIUM BATH		POTASSIUM BATH	
$CuSo_4.5H_2O$		$Cu_2P_2O_7.3H_2O$	110 g./L.
$Na_4P_2O_7.10H_2O$	200 g./L.	$K_4P_2O_7.10H_2O$	404 g./L.
NaCl	30 g./L.	Ammonia	3 g./L.
		Citric Acid	10 g./L.
pH	8.3	pH	8.5
Temperature, 35° C. (95° F.).		Temperature, 49° C. (120° F.).	
Current Density, 10 amp./sq. ft. (1.1 amp./dm.^{2}).		Current Density, 5 to 50 amp./sq. ft. (0.5 to 4.5 amp./dm.^{2}).	

The molar ratio of pyrophosphate to copper should exceed 2, although an excess of pyrophosphate decreases the current density range.

The Stareck-Coyle solutions will give bright deposits if the current densities do not exceed the values cited. Both solutions are

This result suggests that as temperature rises the cuprous diethylenetriamine complex becomes less susceptible to oxidation or that conditions for its discharge at the cathode become more favorable.

* It is possible that the inhibiting action of the nitrate ion lies in its ready reducibility to ammonia and nitrogen oxides. On this basis, then, the more rapid the agitation, the more rapid would be the replenishment of the nitrate ion in the cathode film, and the less would be the tendency of copper to be deposited. A similar argument may explain, in part, the inhibiting action of the chromate ion reported by Wagner and Beckwith.[32] Silverman[58] reports that the inhibiting action of the nitrate ion in an acid copper solution is due to nitrous acid which "retards the electrolytic deposition of copper." He adds sulfamic acid, which decomposes the nitrous acid.

stable with respect to temperature and, since increases in rate of agitation and in temperature permit the use of increased current densities, it would appear that the pyrophosphate copper solution, especially when made with potassium salt, may be usable at current densities higher than those specified. Stareck has disclosed the use of dibasic organic acids (lactic, tartaric, malic, oxalic, etc.) or their ammonium or fixed alkali salts as brighteners. These brighteners are also claimed to increase the maximum allowable current density and the bath conductivity. Other brighteners and addition agents listed are the disulfonic acids of phenol or naphthalene and the chlorides of As, Bi, Fe, Cr, Sn, Zr, Pb, Cd and alkali metals.[59]

The use of a soluble double salt of sodium and copper pyrophosphate as the major constituent of a copper plating solution has also been described by Gamov and Fomenko.[61] Gershevich and Gamburg[62] likewise describe a pyrophosphate solution** as follows: $Na_4Cu_2(P_2O_7)_2.16H_2O$, 180 g./L.; $Na_4P_2O_7.10H_2O$, 13.5 g./L.; $Na_2HPO_4.12H_2O$, 30 to 50 g./L.; pH, 9.3.

A current density as high as 55 amp./sq. ft. (5.9 amp./dm.^{2}) has been used with the foregoing solution although, for heavy deposits, 10 amp./sq. ft. (1.1 amp./dm.^{2}) are recommended. The disodium acid phosphate is necessary to provide good anode corrosion; in its absence passivity may set it. The throwing power (bent cathode test) is reportedly as good as in the cuprocyanide solution and the current efficiency, as in the Stareck bath, should be very close to 100%.

Copper Sulfamate Solutions

Another solution from which copper may be deposited is that containing sulfamic acid (HSO_3NH_2) or its salts. Among the features of sulfamic acid are the water solubility of all known metallic salts except that of mercury[63] and the fact that the metal-acid complexes are stable and soluble both in acid and basic solutions.

Piontelli and Guilotto[63] prepared a molar solution of copper sulfamate (by dissolving cupric carbonate in sulfamic acid); at 37° C. and at a current density of 28 amp./sq. ft. (3 amp./dm.^{2}) they obtained a specular copper deposit. It is interesting to note that these workers state that the following metals also can be deposited from a sulfamic acid solution: Fe, Ni, Co, Cd, Rh, Ag, Pb, Zn.

Cupery[65] has described the use of the sulfamate ion $(SO_3NH_2)^-$ in the electrolyte at current densities not exceeding 45 amp./sq. ft. (4.8 amp./dm.^{2}) from a solution 0.5 *M* (128 g./L.) with respect to copper sulfamate. Incidentally, he confirms the work of Piontelli and Guilotto[63] with respect to deposition of cadmium and zinc. Choguill[64] could also deposit nickel from a nickel sulfamate solution, but was unable to get a bright deposit at any temperature or current density.

Cupery[65] has described the use of the sulfamate ion $(SO_3NH_2)^-$ in the electrodeposition of copper, nickel and lead. His recommended solution for copper deposition is:

Ammonium sulfamate ($NH_4SO_3NH_2$)	100 g./L.	0.88 moles/L.
Copper sulfate ($CuSO_4.5H_2O$)	130 g./L.	0.52 moles/L.
Sodium hydroxide (NaOH)	7.5 g./L.	0.19 moles/L.

At a current density of 35 amp./sq. ft. (3.8 amp./dm.^{2}) the deposit was bright and pleasing in appearance. Cupery does not give any information concerning temperature, current efficiencies or throwing power.

III. Fused Electrolytes

It is quite obvious that electroplating uses an aqueous medium although, within the recent past, organic solutions have been studied. However, the cost of the organic solvents is probably prohibitive for most commercial uses. An extremely limited amount of work has been done in the field of electrodeposition of metals other than aluminum and the alkaline earth metals from fused salts. A very recent paper by Wehrmann and Yntema[66] discusses decomposition potentials of some 19 metals, including copper, in a molten mixture of: $AlCl_3$ (66 Mol %); NaBr (20 Mol %); KBr (14 Mol %). Aluminum was used as a reference electrode.

The use of a molten coper cyanide-alkali metal cyanide bath, operated at a temperature lower than 600° C. has been disclosed by Young.[67]

IV. The Structure of Electroplated Deposits

The microstructure of electrodeposited metals is the subject of three rather comprehensive discussions.[68, 69, 70] The general conclusions to be drawn from these references are: (a) The grain structure of electrodeposited metals follows, very frequently, the grain structure of the basis metal (see Butts and de Nora[70] for a discussion of this topic). (b) Grain size increases as the metal concentration *in the vicinity of the cathode*, increases. (c) Grain size decreases as the amount of material co-depositing with the major constituent increases. (d) Grain size is reduced when "addition agents" are added to the solution, although Marble, using the acid-copper solution, reported a few addition agents which increase the grain size of copper.[71]

While it is quite certain that electrodeposits tend to perpetuate the grain structure of the basis metal, it is also quite clear that under proper conditions of current density this reproduction of the basis metal microstructure is negligible. Thus, Phillips and Meyer found that copper deposited (at 38° C., 100° F.) from an acid copper solution reproduces the grain structure of the basis metal (copper) for current densities up to 20 amp./sq. ft. (2.2 amp./dm.^{2}) but not for current densities higher than that value. Further, the columnar type of deposit normally associated with an acid-copper deposit does not persist when the copper is deposited at current densities greater than 10 amp./sq. ft. (1.1 amp./dm.^{2}); in such cases the grains are equi-axed. When deposits were made from a cyanide solution at current densities under 7 amp./sq. ft. (0.8 amp./dm.^{2}) markings suggestive of grain boundaries normal to the surface could be observed at a magnification of 750x. However, at current densities greater than 7 amp./sq. ft. (0.8 amp./dm.^{2}) the microstructure is not resolvable even at a magnification of 250x.

Cuthbertson[72] corroborated the work of Phillips and Meyer with respect to the structure of copper deposited from the acid-copper solution. He did find, however, that the copper deposit on a fine copper wire (0.018 in. or 0.46 mm. diam.) is slightly columnar very close to the cathode and becomes more or less equi-axed a short distance therefrom. Butts and de Nora[70] also report that copper deposits consist of equi-axed grains when the current density is high. The orientating influence of the basis metal can usually be eliminated by polishing it to a very high luster or, alternatively, the current may be interrupted several times during plating. However, Cuthbertson[72] found that the copper deposited on the copper wire is striated when the plating current is intermittent. When the deposits are annealed, there is considerable segregation at grain boundaries of an impurity believed to be cuprous oxide. The foregoing is an alternative statement of the generalization that copper deposits are often embrittled when they are annealed. Thus, Meyer states that when copper, deposited from an acid solution, is recrystallized at 900° C. (1940° F.) there is no evidence of non-metallic segregations in the grain boundaries; however, deposits from cyanide solutions recrystallize into small equi-axed grains with a quantity of non-metallic matter visible in the grain boundaries.

Weisberg[73] believes that there is a change in the structure of the copper deposit when the free cyanide content is increased and it seems very likely that the amount of basic matter in the deposit, if there is any, is much greater with low free cyanide than with high free cyanide. . . . There seems to be a critical free cyanide content above which the plates are comparatively easy to buff, whereas with low free cyanide the buffing, as everybody knows, is rather difficult."

An application of the tendency for an electrodeposit to conform to the grain structure of the basis metal is reported by Pierce[5] and by Adler and Krinowitz[6] who deposited copper on a steel wire and then drew the composite to the desired size. In order to get a copper grain size somewhat between that given by the cyanide solution and that of the acid solution, they plated, alternately, out of the cyanide and the acid solutions. Grains of copper so deposited are claimed to be larger than those normally given by the cyanide solutions and smaller than those normally given by the acid solution.

An interesting study of the correlation between polarization voltage and crystal structure was made by Boulach[74] who rotated

** (Bath temperature—not specified in Chemical Abstracts.)

a cylindrical cathode at a speed of 800 r.p.m. (equivalent to a peripheral speed of 56 ft. (17m.)/min.). Sound deposits of copper were obtained from an acid copper solution at 47° C. (116° F.) and a current density of 280 amp./sq. ft. (30 amp./dm.²). When the polarization is low, *i.e.*, under 0.008 v., large, visibly oriented crystals are obtained. At higher polarizations, *i.e.*, higher current densities, a very fine grained unoriented deposit is obtained. At still higher polarizations, 0.12 to 0.14 v., the deposits have a "wood-like" structure with a decided orientation.*

The increase in grain size with *increase in metal concentration in the vicinity of the cathode* is a fundamental axiom that has been expressed in much of the work previously cited. Thus, the statements by Butts and de Nora[70] that "rise of temperature was found to increase the grain size of the deposit" and "the grain size was found to become progressively smaller as the current density increased" are corollaries of the axiom. Note that the rate of diffusion increases approximately 2% per 1° C. increase in temperature;[27] as the temperature increases the metal content of the cathode film is thus more readily maintained by diffusion. By the same token, the metal ion concentration in the cathode film decreases as the current density increases (other factors constant) and the grain size becomes smaller. Clifton and Phillips[3] noted that their acid-copper solutions gave mirror-bright deposits at 13° C. (54° F.) but an increase in temperature reduced brightness. A possible explanation for this has just been given, *i.e.*, the copper grains become larger as the temperature increases. Agitation, in that it helps the diffusion process in replenishing the cathode film, should lead to an increase in grain size. That such is, indeed, the case is affirmed by Meyer,[69] "for constant current density, agitation favors the formation of larger crystals."**

As a further example, consider the work of Phillips[25] who determined maximum current density, at several temperatures, as a function of the speed of translation of work through an aqueous copper sulfate solution. The data shown in Table IV are illustrative. In general, the deposits obtained at 80° C. (176° F.) were less satisfactory than those obtained at 54° C. (130° F.).

TABLE IV

***Effect of Temperature and Speed of Agitation Upon Maximum Current Density*[25]**

	Lateral Speed of Agitation, ft./min.		
	0	10	50
Temp.	*C.D. Amp./sq. ft.*	*C.D. amp./sq. ft.*	*C.D. amp./sq. ft.*
24° C.	24	60	72
54° C.	48	72	96
80° C.	60	72	72

These general considerations again find some corroboration in the work of Mahla.[76] While no direct relationship between hardness and stress was observed by him, he did note a general correlation between stress and hardness of electrodeposited copper: a decrease in one was accompanied by a decrease in the other. He found that current density has a greater influence on stress at high temperatures than at low, while for temperatures lower than 45° to 50° C. (114° to 122° F.) stress is more responsive to temperature changes than to current density changes. The relation of these results to those previously discussed is established when it is remembered that, according to Mahla,[76] electrodeposited copper is more highly stressed the smaller are the grains.***

Little consideration has been given in this report to the use of addition agents as a means of modifying the grain size or grain shape of electrodeposited copper. The literature of addition agents is both voluminous and contradictory. After a study of the effect of 76 different addition agents, organic and inorganic, upon the mass and structure of copper deposited from an acid solution, Marble[71] states, "There is no single relationship between the type of deposit and the chemical nature of the addition agent." And, ". . . an addition agent which produces a marked difference in the crystal size of the deposit also produces an appreciable difference† in the mass of the deposit as compared to the control. . . . There is no relationship between the sign of this difference and the effect produced.

The use of a variety of addition agents has been discussed previously in this report: molasses, carbohydrates, thiourea, ammonium thiocyanate, betaines, phenol and naphthalenesulfonic acids, dibasic organic acids and sodium thiosulfate. In all cases, the use of these agents is said to lead to a brighter deposit or an increased current density range, suggesting that the addition agents modify the grain size and shape of the electrodeposited copper.

The use of metallic additions has been discussed by Hull[41] and Stareck[59] and by Phillips and Meyer.[21] Phillips and Meyer[21] found that as little as 0.01 g./L. of lead in the cuprocyanide solution gave very dense compact deposits. The first 0.0002 in. (5 micron) thickness contained 0.6% Pb. When the lead ion concentration is increased to 0.1 g./L., the deposit is dense, bright and contains some radial structures; the first 0.0002 in. thickness contained 1.1% Pb. Finally, when the solution contained 1 g./L. Pb., the deposit was loosely adherent and the first 0.0002 in. thickness contained 35% Pb. and the radial structures were very pronounced. Photomicrographs of these deposits clearly showed the grain refinement produced by the two lower concentrations of lead. Addition of from 0.01 to 1 g./L. of the following metals (as salts) failed to brighten the deposits: Tl., Cd., Ag., Zn., Ni., Co., Sn.

* Note, however, that polarization increases with current density and decreases with temperature, while grain size normally decreases with current density and increases with temperature. Therefore the phrase "influence of polarization on the structure of the deposit" may be misleading since polarization depends on several factors, as does structure of the deposit. The present writer believes that Boulach's data indicate that the polarization and structure changes both reflect changes in current density and other conditions of deposition. This viewpoint is shared by Meyer[69] who said: "It appears to me that too much credit is given to the effects of polarization differences on the structure of the deposits obtained. The changes in the physical conditions of deposition, temperature and current density would account for the changes in the structures. Changes in polarization would be coincidental with changes in the physical condition."

** After all, what does determine the upper limit of cathode current density? Usually, the maximum allowable current density is defined as that current density beyond which the deposit is so fine grained and brittle, possibly because of inclusion of oxides and basic salts, as to be unusable. Yet it has been shown that as temperature, metal salt concentration and agitation (all factors which lead to larger grains) are increased, the maximum allowable current density is increased.

*** While it is quite true that deposits obtained from solutions of complex copper ions (cuprocyanide, pyrophosphate, amine, thiosulfate) are finer grained than those obtained from the acid-copper solution, it is possible that the grain size of deposits obtained from such solutions would increase as metal complex ion concentration, temperature or degree of agitation increases. This conclusion is based on the fact that these factors permit the use of *higher maximum cathode current densities than ordinary*. (See references as follows: thiosulfate solution, 9; rochelle salt-cuprocyanide, 29, 30, 32, 38; high speed cyanide, 42; diethylene triamine, 51; pyrophosphate, 59.)

† At least 2%.

Conclusions

It is clear that copper can be electrodeposited from a large number of entirely different plating solutions. The choice of a particular solution would, then, depend upon the following considerations: (a) the physical nature of the desired deposit; (b) the basis metal; (c) required thickness of deposit and time available for plating; (d) cost of materials.

The dependence of the metallurgical nature of the electrodeposited copper has been discussed with respect to the following factors: (a) solution composition; (b) current density; (c) temperature; (d) agitation; (e) addition agents.

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* C. A. = Chemical Abstracts.

The Job or Contract Electroplating Business in 1945

Following is a brief report on the industry from the Masters' Electro-Plating Association, 123 William Street, New York 7, New York. This Association comprises 77 member firms whose output is estimated at approximately 80% of the total plating work done in the Metropolitan District.

Business Developments

The Rate of Operations in 1945 reflected the general trend of events during the year. In January it was 87%; it went to a high of 89.5% in March, and then decreased gradually to 85% in July. At this time the method of calcuating the Rate of Operations was changed to cover the greatly increased capacity in the industry (from about 65,000 to 100,000 man hours per week) and the new figures reflected this change for the balance of the year. In August the rate was 70%; September 64%; October 67%; November 63½% and December 72%. If the same method of calculation had been used in starting in January, the Rate of Operations would have ranged from 72% in January to 74% in March, and down to 70½% in July.

Summarizing the above figures, it is clear that the end of the war resulted in an immediate noticeable recession. However, this recession was much less than had been feared and the shops are operating on a schedule which is keeping them busy to the limit of the available labor force. The factor which most greatly limits the Rate of Operations at this time is the critical shortage of polishers. According to a survey of the Membership, the industry is in a position to employ as many as 300 additional polishers at this time.

Apprenticeship Program. In order to solve the problem of the shortage of polishers, a training program for apprentice polishers and platers has been submitted by the Association to the War Manpower Commission. As soon as this plan has been approved and authorized, the program will be put into effect. It will be made immediately available to all members of the Association.

The Commercial Rent Control Law which the Association joined in helping to place on the statute books of New York State, is still in operation and the Joint Rent Action Committee on which the Association is represented, is continuing its activities to extend the law and continue the protection of business firms against excessive rent increases.

Surplus Government Property, including plating and polishing equipment is now available from the Reconstruction Finance Corporation, Surplus Property Division, 70 Pine Street New York 5, New York.

Government Restrictions have been voked on practically all materials used electroplaters, except tin and chrom chemicals, (chromic acid, chromates, during the past year. Electroplating eq ment is now freely available. Neverthe certain materials are still in short sup such as silver, nickel, buffs, degreas chemicals, etc. The price of foreign s was increased by the OPA from 45c oz. to the level of domestic silver, 71. per oz.

Contract Termination. VJ Day which sulted in a flood of contract cancellati brought few termination problems t electroplaters whose work was largely s contract in nature, and whose bills w to other contractors rather than dire to Government agencies. Nevertheless, Association sent to all members a B on Contract Termination on September 1 with instructions for making claims payment and for interim financing.

Price Cutting. With the termination war contracts and the reversion to civil work, came some reports of price cutti However, the total amount of such cutti was comparatively small being limited only a few firms. At the present time, pri are still being maintained with no pa pricing or estimating in evidence.

Labor

The labor situation during the past year has been unsettled, to say the least. In a dispute case between a number of Member Platers and Local 8 of the Metal Polishers Union, the WLB awarded the Union 6 paid holidays, and vacations ranging from one week to two weeks, depending upon the length of employment. Negotiations with the Union for a blanket contract to cover all union shops have been unsuccessful so far. It is hoped, however, that they may be resumed at an early date in the interest of stabilizing the industry and maintaining orderly and friendlier relations.

The Union at this time is making demands for sharp increases in wage rates, substantially above the rate ranges which they agreed upon with the employers in their petition to the WLB.

It is felt by a number of the Members that with the new vacation rules in effect, it will be worth while to close their shops for at least a full week during the summer, giving a vacation with pay to all those employees who are entitled to it. It is also felt that it is more beneficial to the workers if the vacations are taken in the form of a rest rather than additional pay.

A strike was called at the shop of Philip Sievering Inc. on November 15th, which came to an end on January 15th, 1946.

Behind the Labor Headlines. We are now witnessing a fight by labor to keep pay envelopes as thick as they were during the war, even though working time is reduced. Big companies and big unions have squared off for a showdown and now all business, small and large, is feeling the effects.

The Government has supported moderate pay increases but has not come out openly against immoderate increases.

President Truman's wage price speech and executive order in October settled nothing. It contained no formula, no definite method of calculation. As a result employers have met increased wage pressure and their bargaining position has been weakened. The overall effect has been more strike action for immediate pay boosts.

OPA Restrictions

Maximum Price Regulation 3581, effective March 31, 1945, set ceilings for job plating prices. The Association had been aware of the impending order for a number of months and had taken the necessary steps to inform members of it and to prepare them in advance. Complete instructions were given to all members for filing and compliance with the regulation to avoid difficulties with the OPA. As a result, none of the members have reported any complaints or investigations, to date. Also the regulation was of such character that it permitted the industry to continue operating on an even keel, earning fair, although not excessive profits and to remain in a stable position.

Executive Committee

At the annual meeting of the Association held on January 10, 1945, the following members were elected to the Executive Members for the ensuing year:

Charles Dietrich, Dietrich & Sons, Chairman
Irving Berkman, Berkman Bros.
Joseph Brust, Brust Bros.
John J. Fannon, Muller Art Plating Works
Sidney Rosenthal, National Chromium Corp.
Walter Plumacher, R. Plumacher & Sons
Philip Sievering, Philip Sievering, Inc.

This committee managed the affairs of the Association successfully, increasing its membership and keeping the treasury in an excellent condition.

Association News

During the past year, the Association membership increased to 77 shops, the new members being the following:

B & F Plating Co., N. Y.
Everstyle Metal Prod. Corp. L. I. C.
General Specialty Co., N. Y.
Harlem Chrom. Plat. Co., N. Y.
Ideal Polishing & Plating Co., Bklyn.
National Electro-Plating Corp. Bklyn.
Regent Metal Prod. Inc., N. Y.
Sorenson Art Platers, N. Y.
West End Chrom. & Nickel Pltg. Co., Bklyn.

The Annual Banquet of the Association was held on Friday, December 14, 1945, at the Park Central Hotel, New York City. Approximately 140 people attended.

One of the features of the evening was a presentation of an engraved placque to Walter Plumacher of R. Plumacher & Sons, N. Y., in recognition of his unique and valuable services to the plating industry. At the same time an orchid was presented to Mrs. Plumacher in recognition of her aid and importance in the firm of R. Plumacher & Sons. Mr. Plumacher in acknowledging the testimonal, introduced his Mother, Mrs. A. Plumacher as one of the founders of the Company, almost 50 years ago.

A notable event of the year was the award of the Army-Navy E to the Imperial Plating Co. of Brooklyn for their fine record in the production of war materials.

Prospects and Plans for 1946

There are many foggy spots ahead in 1946. However, it still may be the most prosperous year in peacetime history—regardless of strike and supply troubles, and regardless of the contradictory forces that will be at work.

Demand and buying power justify optimism, but how high production goes will depend on several factors with a less rosy outlook.

1. *Supply* of many materials is short; steel, especially sheet, is most critical at this time.
2. *Manpower* Problems of obtaining and retaining help; getting war workers to move down to lower pay scales in civilian jobs; strikes.
3. *Cost price-profit uncertainties*: will slow up return of some production but mid-year should bring brighter picture with wage and material costs somewhat stabilized, production high enough to restore management's control of over-all costs, bottleneck prices adjusted, new producers and war-closed establishments back in the race.
4. *Labor Prospects* Possible trouble all through 1946.
5. In Washington, no clear policy; compromise, with eye on 1948.

It is the plan of the Association to devote as much time as possible during the year to the subject of Costs and to hold meetings on this topic whenever possible. It is hoped that the labor situation may be resolved and that the efforts and energies of the Association may be devoted to constructive improvements in the methods of operation including the technical factors such as production control, plant and equipment layout, etc.

THIS IS WASHINGTON—

By George W. Grupp
METAL FINISHING's Washington Correspondent

Baltimore-Washington Branch Holds Its Annual Meeting The Eighteenth Annual Educational Session and Dinner Dance of the Baltimore-Washington Branch of the American Electroplaters' Society, which was held at the Maryland Yacht Club, Baltimore, Maryland, on February 16, 1946, was not only one of the most successful in the history of the Branch, but it was also an afternoon and evening chocked full of fun, with plenty of food for thought. Everyone was happy; and the older ones were not wallflowers when Roby's Orchestra played tunes for terpsichorean exercises.

Professionals Entertain Members The Banquet Committee (Frank L. Davey, Bradford D. Clark and Jules Horelick), saw to it that the members and their wives and guests were served a delicious dinner and provided with an hour's fun by professional contortionists, comedians, jugglers, tap dancers, rope artists, and singers. And the Branch's genial member, Thomas Slattery, delighted everyone with his singing.

Slattery Presents Pinner With a Golden Bowl Just before the hour of professional entertainment the dining hall vibrated with gales of laughter when Thomas Slattery made one of the most colorful speeches of his life in presenting Walter L. Pinner with a difficult to describe gold and silver plated vessel which some might call a bowl for the want of a better word. In accepting the whatever one wants to call it, Walter L. Pinner sent the members of the branch and others "rolling in the aisles".

Members' Wives Engage in Lively Card Game During the educational session, the hostesses (Mrs. Ken M. Huston and Mrs. L. G. Tubbs of Baltimore, and Mrs. A. G. Pierdon and Mrs. William Blum of Washington), arranged a card party for the members' wives and guests. The rivalry was keen to capture one of the prizes donated by the Egyptian Lacquer Mfg. Co. and the Oakite Products Co. The winners of these coveted prizes were Mrs. L. L. Turner of Baltimore; Mrs. T. M. Rodgers of Philadelphia; Mrs. Robb A. Earhardt of Summit, New Jersey; Mrs. A. G. Pierdon of Washington; Mrs. L. G. Tubbs of Baltimore; and Mrs. Kenneth M. Huston of Baltimore.

Distinguished Members of the Industry Address Educational Session The educational session, which was presided over by Kenneth M. Huston, president of the Branch and vice president of the American Electroplaters' Society, was addressed by F. C. Mesle, superintendent of the Bearing Plate Division of Oneida Limited, Oneida, N. Y., and past supreme president of the AES; by Walter L. Pinner, supreme president of the American Electroplaters' Society and technical manager of the Houdaille-Hershey Co. Detroit, Mich.; and by Robb A. Earhardt, finish engineer, Bell Telephone Laboratories.

Plating Aluminum Discussed by Earhardt In his paper on "Practical Application of Plating on Aluminum," illustrated with lantern slides, Robb A. Earhardt dealt with the experiments conducted by the Bell Laboratories with immersion zincates followed with electroplating various metals on aluminum. In his paper he gave some of the plating solutions used; he mentioned the kind of apparatus used; he described the methods of preparing specimens; and he told of the results of the different experiments. As a whole it appears that the experiments revealed that the corrosion protection afforded aluminum by electroplated coatings was unsatisfactory; and it was found that such coatings do not compare favorably with the protection offered by anodic coatings.

Pinner Talks on High Speed Bright Nickel Plating Walter L. Pinner in his paper on "High Speed Bright Nickel Plating With the High Chloride Ion Bath" illustrated with lantern slides, told of investigations to evaluate the Wesley and Carey process to determine its utility as a commercial method for decorative plating. In conducting this investigation it was found that normal purification procedures for the all-chloride bath were found to be difficult, since a pH higher than 5.0 was reached only with difficulty on treating the bath with nickel carbonate; and a lime treatment was found to be not much more effective. In describing the apparatus used in the experiments he revealed that no lead tanks should be used. He pointed out that the tanks should be lined with rubber. Pitting, he said, can be controlled by the use of peroxide. At the conclusion of this paper, Dr. A. Kenneth Graham, secretary of the American Electroplaters' Society, and Dr. William Blum of the National Bureau of Standards contributed some enlightening thoughts.

Mesle Speaks on Silver Plating Bearings Frank C. Mesle illustrated his paper on "Heavy Silver Deposits on Airplane Bearings" with many actual specimens, and a large number of graphic charts and photographs. In his paper he dealt with the various factors involved in silver plating bearings to meet Government specifications. He also treated on the reasons for using silver; the methods of masking for selective plating; the procedure for cleaning and striking to get a satisfactory bond; the methods of controlling the thickness of the silver; the methods of obtaining a satisfactory deposit of 0.040" to 0.060" thick; and the structure of silver deposit.

Four Past Presidents of the Supreme Society at Meeting The annual meeting of the Baltimore-Washington Branch was graced with the presence of four past presidents of the American Electroplaters' Society, namely: Mr. Mesle (1926); George Gehling (1930); Thomas Slattery (1935); and Frederick Fulforth (1940).

Bureau of Standards Cooperating With Jewelry Trade on Plating The National Bureau of Standards is working with the jewelry industry on a standard to control the quality of gold electroplating. And it is revising for them the standard for marking gold and silver combinations.

"It Pays to Advertise"

Over 25 years ago the New York theatregoers were thrilled and impressed by a play called "It Pays to Advertise". That is the policy of D. L. Bromwell, the Washington silversmith and plater. In one of the local newspapers he ran a display advertisement which occupied about one-sixth of a page. It was a very dignified advertisement which informed Washingtonians that he was prepared to perform plating and lacquering services. This is what other platers should do to stimulate business for the finishing industry.

Electroplaters Urged to Use Substitutes for Cadmium

The Civilian Production Administration told members of the Cadmium Distributors Industry Advisory Committee on February 15, 1946, that the electroplating industry must use other metals to prevent an early exhaustion of the cadmium supply. The CPA reported that the current electroplating of bobby pins, pin ball machines and other nonessential products with cadmium exceeds the pre-war level. If this demand continues, the CPA warned it would place new restrictions on the use of cadmium.

President Truman States His Policy on Prices and Inventories

In an effort to maintain balance and to stimulate the flow of goods, President Truman recently pointed out that he is "directing that all administrative agencies use their full legal powers, including emergency powers delegated to them under the Second War Powers Act, to assist the OPA in meeting the Government's responsibility for retaining control over the forces of inflation." And he added: "Priorities and allocations powers will be used vigorously wherever necessary to prevent increases in prices. There will be a strict enforcement of inventory controls. The resources of the Treasury and Justice Departments will be called upon when necessary to assist in enforcing these controls."

Treasury to Make a Drive on Income Tax Evaders

The House Appropriations Committee recently approved a bill which will supply the Treasury Department with funds to crack down on tax evaders. William T. Sherwood, assistant commissioner of the Internal Revenue Department, feels that at least an additional one billion dollars will flow into the Government treasure chest as a result of this drive.

A Scientific Department of Cabinet Status May Be Created

The Hon. Clare Booth Luce of Connecticut recently introduced a bill to create a Department of Science and Research whose executive head will have cabinet status. The bill provides that "the purpose of the Department of Science and Research shall be to foster, promote and develop the study and spread of scientific knowledge and its practical application to the enforcement of peace and the attainment of high living standards throughout the United States and the world." The proposed department is to have five bureaus, namely: (a) Bureau of Physics and Mathematical Science; (b) Bureau of Health and Social Science; (c) Bureau of Scientific Education and Information; (d) Bureau of Biological Science; and (e) Bureau of Engineering and Technological Sciences.

"Government Financial Aids to Small Business"

The Department of Commerce has just released a 39-page pamphlet called "Government Financial Aids to Small Business" which is a guide to small business men in dealing with banks and other lending agencies. This booklet may be obtained from the Superintendent of Documents, Government Printing Office, Washington 25, D. C., for the sum of 15 cents.

Congress Passes Employment Bill

The employment bill which Congress passed last month and sent to the White House for the President's signature fell short of the "full employment" plan proposed by President Truman. For example, Senator Barkley told the Senate that the word "full" was deleted because it carried an "implied guarantee that the Government would step in and provide jobs for all unemployed". The bill provides that the "continuing policy and responsibility of the Federal Government" shall be to "use all practicable means consistent with its needs and obligations with the assistance and cooperation of industry, agriculture, labor and State and local governments, to co-ordinate and utilize all of its plans, functions and resources for the purpose of creating and maintaining, in a manner calculated to foster and promote free competitive enterprise and the general welfare, conditions under which there will be afforded useful employment opportunities, including self employment, for those able, willing and seeking to work, and to promote maximum employment, production and purchasing power."

Commerce Department Gets Set to Help Small Business in Conducting Research

A recently established Production Research and Development Division of the Department of Commerce plans to initiate and conduct research and development work on materials and processes and inventions which will advance the technological productivity of the country. To carry out these functions, within the limit of funds available for the purpose, it will arrange for research and development projects to be performed by colleges and universities and appropriate federal and non-federal agencies.

WAC Expects to Change Its Surplus Pricing Policies

To speed up surplus consumer goods sales, the War Assets Corporation is considering plans to revise the present pricing and distribution policies.

Patent Office Is Being Swamped With Applications

Casper W. Ooms, Patent Commissioner, has revealed that the number of applications for patents have increased almost fifty per cent since V-J Day. In fact they are being received at the rate of about 8,000 a month, the highest rate in the history of the Patent Office.

Congress Asked to Create Tax Rebate Courts

The Congressional Joint Taxation Committee has been asked to prepare legislation for the creation of six regional tax rebate courts which will hear and act upon business claims for excess profits tax relief under Section 722. It is proposed that these courts, not the usual Internal Revenue Bureau agents, should determine what is "fair and just amounts", and "normal earnings".

What Will Congress Do About Metal Purchase Subsidies?

The government purchasing of relatively scarce metals such as antimony, copper, lead and tin in the future will depend upon the action of Congress to extend wartime subsidies. Should Congress decide against such subsidies, then the inflated prices of raw materials will exert pressures against domestic price ceilings.

Davis Suggests Patent Law With Side Door Left Open

William H. Davis, chairman of the Commerce Department's Patent Survey Committee, recently declared that he is opposed to legislation which would make the licensing of patents compulsory. But he makes an exception by stating that "a properly drawn bill requiring issuance of a license in cases where the patent owner is withholding manufacture without good reason would be a good thing." And now one might ask: who is to be judge on whether a manufacturer has or has not a "good reason" for withholding manufacture?

OPA Recognizes That Wage Raises Increase Production Costs The Price Administration is working on a policy which will break the present lack in production. OPA seems to be aware that wage increases force the cost of production to go up and that prices must be increased.

Government Surplus Will Reach 52 Billions According to an official estimate, the government's surplus property is expected to reach the staggering figure of $52,000,000,000 by June, 1947. About $15,000,000,000 of this surplus is located abroad.

What It Costs the Worker to Strike The American Federation of Labor's publication called "Labor's Monthly Survey" has made this very interesting observation on the cost of strikes. It says: "Suppose the workers are earning an average of $1.00 per hour. The company offers an increase of 12c to $1.12, but the union turns down the offer because they think a government board may give them more. They go on strike and stay out for eight weeks. Each worker loses an average of $358 (pay for 8 weeks of 40 hours at $1.12). At the end of that time the government board awards 18c, 6c more than the company offered. The company accepts the award and grants 18c, but it will take the workers nearly three years' work before this extra 6c will amount to enough to repay their loss."

Arnold Appointed Acting Head of Office of Small Business Secretary of Commerce Henry A. Wallace has appointed Laurence F. Arnold as Acting Director of the newly organized Office of Small Business.

OPA to Be Asked to Readjust Prices Eric A. Johnston, president of the Chamber of Commerce of the United States, has urged the local chambers of commerce to take action to overcome the reluctance of OPA to make price adjustments which are urgently needed.

Reopening Wage Clauses May Prove Too Embarrassing Some industrialists are of the opinion that those small plants which have granted wage increases with the understanding that the rate will be adjusted when the large companies have granted a greater increase are endangering their competitive position. While such an agreement makes it possible for small business to avoid strikes, yet they can be placed in an awkward position for their reopening clauses provide that the unions can seek full adjustment on 20 to 30 days' notice.

Gregory Will Head WAC President Truman recently nominated Lt. Gen. Edmund B. Gregory to be the head of the recently organized War Assets Corporation. This Corporation takes over the activities of the Surplus Property Administration which is in the process of liquidation.

Metal Musical Instrument Manufacturers May Apply for Price Increases In order No. 7 under Maximum Price Regulation No. 188, issued on February 14, 1946, the Office of Price Administration granted permission to manufacturers of metal musical instruments to apply individually for price increases that will yield each firm its own average peace time earnings, or half the industry's average earnings, whichever is the greater. Distributors and retailers will be required to absorb substantially all the increases given to individual manufacturers.

Copper Production Dropped in 1945 The Copper Institute reports that the production of crude copper during the year 1945 amounted to 841,667 tons as compared with 1,056,180 tons in 1944, with 1,194,699 tons in 1943, with 1,152,344 tons in 1942, and with 1,016,996 tons in 1941.

Domestic Gold Production Increasing The Bureau of Mines of the Department of Interior reports that the production of domestic gold continues to show a rapid upward swing.

Tin Supply Outlook According to some observers, there will be a gradual improvement in the tin supply during the second half of 1946; and it is their opinion that the balancing of supply and demand of tin will not take place until July, 1947.

Slab Zinc Production Declines in 1945 The American Zinc Institute reports that the domestic production of slab zinc during the month of January, 1946, amounted to 65,950 tons. During the same month slab zinc domestic shipments totaled 57,659 tons; and the stockpile amounted to 266,65[illegible] tons. During the year 1945 the total production of all grades of slab zinc amounted to 799,462 tons as compared with 901,330 tons in 1944; with 971,873 tons in 1943.

Tinplate to Be Channelled to Container Production For some time after the settlement of the steel strike the Civilian Production Administration will channel tinplate into the production of containers for perishable and seasonable foodstuffs.

Copper Shortage Averted The shortage of copper which was predicted for the first half of 1946 has suddenly become bright by the resumption of imports—resumption of Government purchases of foreign copper to build up a stockpile which will be released to consumers to take the pressure off between demand and supply. Domestic production of copper has been retarded because of labor shortage, strained labor relations, delay in seeking new deposits, and the postwar policy of the Government.

Report on Corrosion Issued The Department of Commerce's Office of the Publication Board has just released a report on information obtained in Germany entitled: "Corrosion Resistance of Magnesium Alloy Sheet in Contact with Dissimilar Metals." This report, which is 20 pages long, may be obtained at the price of $2.00. A microfilm of the report may be obtained for fifty cents.

Corundum Controls Will Not Be Eased at Present The Civilian Production Administration has revealed that the present control of corundum under M-89 will not be relaxed until there is a more than ample supply of this material. But it is encouraging to note that the stockpile is increasing.

Silver Production Fairly Even The Bureau of Mines of the Department of Interior reports that the monthly production of silver in the United States has been fairly even since June, 1945.

WAC to Help Ease Metal Shortages To ease the shortage of metals, the War Assets Corporation will offer surplus metals wherever and whenever stockpiles of such materials become available. In fact the WAC expects to sell an average of $15,000,000 worth a month. Metal inventories in WAC warehouses are being divided into three categories: 1, useable material; 2, small loss with a value of less than $300, and 3, non-marketable material.

Zinc Coatings Will Exceed 1941 Level Ernest V. Gent, secretary of the American Zinc Institute, recently expressed the opinion that galvanizing has resumed its place as the principal use for zinc. He also expressed the opinion that in 1946 the consumption of zinc for protective coatings will exceed the 1941 level of 350,854 tons.

SHOP PROBLEMS

PLATING AND FINISHING
POLISHING—BUFFING
CLEANING — PICKLING
HOT DIP FINISHES

METAL FINISHING publishes, each month, a portion of the inquiries answered as a service to subscribers. If any reader disagrees with the answers or knows of better or more information on the problem discussed, the information will be gratefully received and the sender's name will be kept confidential, if desired.

Bright Dipping

Question: Please advise us where to get more details on Bright Dipping than are contained in the *Plating & Finishing Guidebook.*

We are interested in any new methods or processes in which dipping is used in the finishing of brass or bronze hardware.

One of our immediate problems is the bright dipping of brass after burnishing; present methods leaves work duller after dipping than before.

K. G. S. F.

Answer: More detailed information will be found in Blum and Hogaboom's "*Principles of Electroplating and Electroforming*," pages 146-150.

We would expect your work to be duller after bright dipping than after burnishing the surface. The brass articles should be bright dipped before burnishing, not after. The bright dip produces a diffuse reflection.

Silver Cyanide Solution

Question: We had two of our silver cyanide solutions assayed. The report is:

No. 1:		
Silver	3.98	troy oz. per gal.
Free cyanide	7.75	" " " "
Total carbonates	6.83	" " " "
No. 2:		
Silver	2.45	troy oz. per gal.
Free cyanide	3.93	" " " "
Total carbonates	5.03	" " " "

Could you tell us what is wrong and how we can correct the trouble?

M. S.

Answer: There is nothing wrong with the analysis you report and we are, therefore unable to advise as to its correction without knowing what trouble is being had.

Strip Solution

Question: I am writing to inquire about a good strip solution for nickel on steel.

We have been using a sodium nitrate strip. However, the results are none too good.

We are wondering if you know of a better strip or can give us the best operating conditions for the nitrate bath.

We know the A. E. S. research committee is working on the problem, but we need an answer before their work is completed.

Any information you can give us will be greatly appreciated.

K. H.

Answer: The sodium nitrate must be closely controlled to prevent pitting. We would suggest that you try the sulfuric acid strip which is made up of:

Sulfuric acid	5 parts by volume
Water	3 " " "
Six volts—reverse current	
Lead cathodes.	

Plating Equipment

Question: We are interested in the plating of musical instruments, mouthpieces, etc. Also information on plating equipment.

R. W. H.

Answer: The subject of plating is too broad to be handled by correspondence but we are forwarding, under separate cover, a copy of our *Buyer's Directory* which lists manufacturers of such equipment.

Electrolytic Polishing

Question: I am working my way through school and have done a great deal of work on electro-polishing of metals. In my July issue of "Metal Finishing," I read "Electrolytic Polishing of Stainless Steel and Other Metals," by Mr. Otto Zmeskal. I will greatly appreciate any information you can give me concerning the owner of the patent rights of the following baths:

1. Perchloric acid and water
2. Perchloric acid, acetic anhydride, and water
3. Perchloric acid, glacial acetic acid, and water.

C. T. S.

Answer: The only patent we find on these solutions is one by Figour and Jacquet—French patent 707,526.

Plating Master Recordings

Question: Will you please give me complete process and specifications on plating up master recordings?

I may be called upon to engineer the plating department in a new record factory. Would like to know the best methods in current use, including thickness, metals, solutions, etc.

J. A.

Answer: The complete process and specifications is too large a subject to be handled by correspondence but we would suggest that you examine an article by Schor in *Metal Industry*, Volume 36, pages 418-20 (1938).

If you cannot see a copy at your local library, you may obtain photostatic copies from the New York Public Library.

Plating Jewelry

Question: Is it possible to electroplate a spectrum color on jewelry, etc.

E. K.

Answer: Various colors may be obtained with the following:

Ammonium molybdate	40 g./L.
Sodium cyanide	2 "
Temperature	70-90° C.
Platinum wire anode	

Ammonium carbonate may be added as a conducting salt.

A process called Electrocolor is available for producing spectrum colors. The process is owned and marketed by United Chromium, Inc., 51 East 42nd St., New York 17, N. Y.

It involves deposition from a copper lactate bath.

Plating Gold on Steel

Question: Can you advise us the quickest and simplest way to put a thin coating of gold direct on steel?

This will be used only occasionally so it must not require elaborate equipment.

D. G.

Answer: A procedure has been patented for electroplating gold on steel and involves the following:

1. Dip for 30 seconds to 1 minute in:
   35% fluosilicic acid—50 to 100 parts by volume.
   35% hydrofluoric acid—5 parts by volume.
   Water—25 to 50 parts by volume.
2. Plate in:

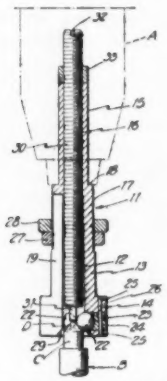
Potassium cyanide	10 g./L.
Potassium carbonate	8 "
41% potassium gold cyanide	2 "
Ammonium benzoate	0.25 "
Sodium formate	0.25 "

(Kushner, U. S. Pat. 2,227,454.)

Patents

Burnishing Tool

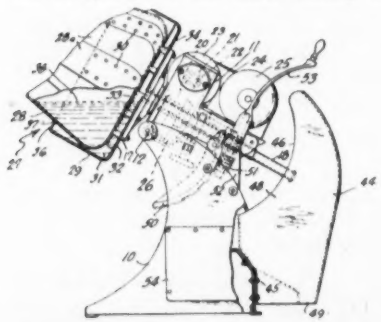
U. S. Pat. 2,390,651. J. W. Iseman, assignor of one-half to Luis De Urzaiz, Dec. 11, 1945. A rotary burnishing tool comprising in combination, a tubular body having a head end, a group of like spherical burnishing elements mounted in the head end



of said body in concentric relation to the axis thereof, like tension means urging the burnishing elements toward the axis of said body, whereby the conical end of a piece of work may be inserted axially into the head end of said body for engagement with the burnishing elements, and a stop member threaded in said tubular body having its inner end disposed adjacent the group of spherical burnishing elements for regulating the distance of insertion of the work into the head end of the tool.

Washing Barrel

U. S. Pat, 2,391,634. A. J. Lewis and L. W. Barnes, assignors to The Baird Machine Co., Dec. 25, 1945. A washing barrel comprising a rotatable receptacle to hold the articles to be treated and liquid for treating the articles, a conduit for conducting liquid from the receptacle arranged with its inlet above the normal level of the liquid in the receptacle at all times during the



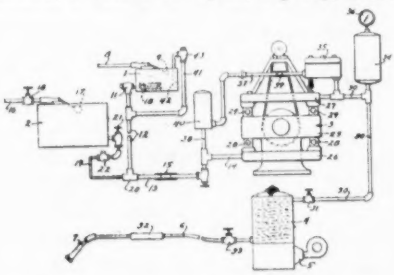
treating operation, a bucket extending radially from said inlet in a direction laterally from the axis of rotation and arranged with its open side facing in a direction transversely of the axis of rotation so that when the receptacle is rotating in one direction the bucket will collect the liquid and conduct it to said inlet and when the receptacle is rotating in the opposite direction is inoperative to collect the liquid, and means for rotating the receptacle in opposite directions.

Tarnish Prevention

U. S. Pat. 2,390,791. G. W. Jernstedt, assignor to Westinghouse Elec. Corp., Dec. 11, 1945. The method of applying a protective corrosion and tarnish-resisting coating to surfaces of members, which comprises, in combination, making the member to be protected the cathode in an electroplating bath, the electroplating bath containing salts of the metals selected from the group beryllium and aluminum, the concentration of the metallic salts corresponding to the molar equivalent of 1 to 6 grams of $BeSO_4.4H_2O$ per liter, ammonium hydroxide to effect precipitation of a portion of the metal salts and to provide for an initial hydrogen ion concentration of 5.5 to 5.9 and from about 1 to 7.5 grams per liter of boric acid to provide for a uniform coating, passing a current of from 20 to 200 milliamps per square foot of surface of the members, to effect the electrodeposition of a layer of material from the bath, and thereafter heat-treating the member with the electro-deposited layer in air at a temperature of about 250° C. to 400° C. to provide for a uniform and durable protective coating.

Cleaning Machine

U. S. Pat. 2,391,177. J. F. Malsbary, assignor to Malsbary Mfg. Co., Dec. 18, 1945. In a cleaning machine of the character described, a source of liquid, a pump, a con-



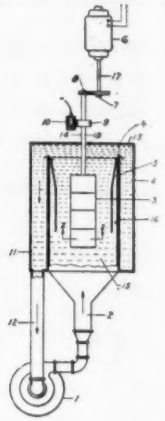
nection between the source and the pump intake, a liquid-receiving element, a connection between the pump outlet and the latter element having a compression chamber and relief valve therein, a by-pass connection between the relief valve and the pump intake whereby excess liquid may be returned to the pump intake in a circulatory path, and a suction chamber in said by-pass connection for accommodating excessive surges in the latter.

Alkaline Detergent

U. S. Pat. 2,391,647. C. Schwartz, Dec. 25, 1945. An alkaline detergent composition for cleaning tin, comprising by weight about 60 to 93% alkali-metal metasilicate, about 3 to 20% alkali-metal perborate, and about 1 to 10% of a water-soluble salt of zinc and about 1 to 10% of at least one inhibitor of the group consisting of a water-soluble salt of magnesium and an alkali-metal silicate having a ratio of M_2O to SiO_2 of not over 1:2, wherein M represents a member of the group consisting of sodium and potassium.

Silver Plating

U. S. Pat. 2,391,039. R. A. Schaefer, assignor to The Cleveland Graphite Bronze Co., Dec. 18, 1945. A method of producing a thick non-porous silver plate by el- deposition on a metal article which prises pre-treating the article by plating a thin layer of nickel and a silver mounting said article for rotation as a ode and circulating an electrolyte over cathode while rotating the same, said trolyte consisting of per liter 40 to 50 g silver cyanide, 35 to 40 grams potas cyanide, 40 to 50 grams potassium carb



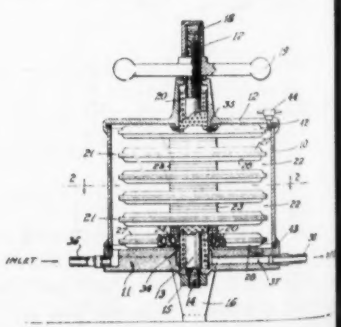
and 10 to 14 grams potassium hydr the current density being 75 to 200 am per square foot.

Rust Prevention

U. S. Pat. 2,392,102. P. M. Ruedrich signor to Tide Water Associated Oil Jan. 1, 1946. A rust-preventive compos having the following approximate form wool-fat having its normally contained partially saponified with an alkaline metal hydroxide, 50 to 80 parts; wax, 50 parts; a solvent for said wool-fat and wax, 500 to 2000 parts; a surface ten depressant, 0.1 to 1 part; and an hom nizer capable of rendering the constit mutually completely soluble, 0.5 to 5 pa said partially saponified wool-fat being like and substantially homogeneous at nary atmospheric temperature.

Filter

U. S. Pat. 2,392,354. S. Alsop, Ja



1946. A filter comprising a base, a removably secured in the base, a casing supported on the base around the pos removable perforated tube surrounding post but leaving an outlet passage betw the post and tube, a removable top p resting upon the upper end of the ca wall, a filter pack supported on the tube composed of a series of removable units

LIXOL

Cowles FAST ACTING EMULSION SOLVENT CLEANER

LIXOL works fast and is a dependable emulsion cleaner for still tank, pre-soak or washing machine equipment. It can be used straight or diluted with water or kerosene.

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- LIXOL cleans thoroughly
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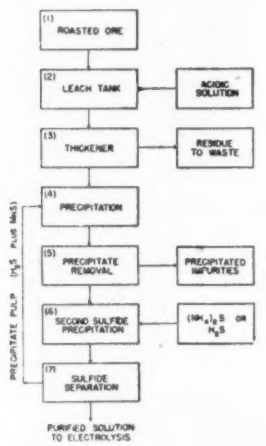
of which is formed of two pads connected at their peripheries and having spacing means between the peripheries and the tube, filtering pulp washers separating the bottom unit from the base, the adjacent units from each other and the top unit from the top plate, the top plate and the base having annular shoulders engaging the adjacent washers, means for admitting liquid to the inside of the casing around the filter pack and clamping means engaging the upper end of the post and the top plate for compressing the parts of the filter pads together between the base and the top plate.

Manganese Bath

U. S. Pat. 2,392,385. J. W. Hunter, Jan. 8, 1946. The process of purifying substantially neutral manganese electrolyte solutions containing manganese and ammonium sulphates, which includes the steps of adding to the solution a freshly-prepared precipitate comprising manganese sulphide, agitating the solution, separating the resulting precipitated impurities, treating the solution so obtained with a soluble sulphide whereby to



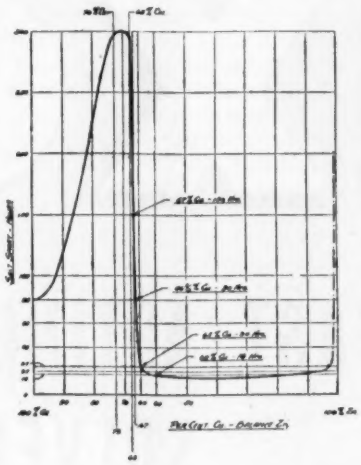
precipitate as the sulphide a portion of the manganese in the solution, and separating the resulting precipitate, the precipitate obtained from the last mentioned step being employed in the first mentioned purification step.

Bright Copper Bath

U. S. Pat. 2,391,289. J. F. Beaver, Jr., Dec. 18, 1945. A bright copper plating bath comprising copper sulfate, sulfuric acid, a brightener in proportion of from 0.005 to 0.1 ounce per gallon, said brightener being selected from the group consisting of aryl and alkyl substitution products of thiourea and acetyl, hydrochloride, nitrate and metal salt derivatives of thiourea, a wetting agent in proportion of approximately 0.3 ounce per gallon, said wetting agent being selected from the group consisting of sodium salts of sulfated alcohols, sodium salts of sulfated alcohols which contain cetyl compounds, isopropyl naphthalene sulfate, sodium lauryl sulfate and a substance adapted to permit high current densities in proportion of approximately 0.25 ounce per gallon, said substance being selected from the group consisting of dextrin, sugar and sulfonated creosote.

Thermal Diffusion of Deposits

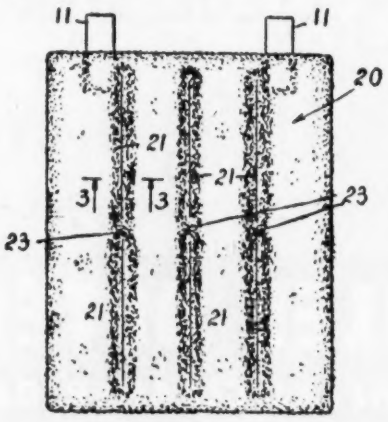
U. S. Pat. 2,392,456. H. Brown and C. R. Hurley, assignors to The Udylite Corp., Jan.



8, 1946. The method of coating a ferrous surface comprising electrodepositing a copper coating on said surface, thereafter electrodepositing a zinc coating on said copper deposit, the ratio of the thickness of the copper coating to the thickness of the zinc coating being such that the copper coating comprises from 68% to 73% by weight of the combined weight of the copper and zinc deposits, and then heating the two deposits at alloying temperatures to cause some of the copper and all of the zinc to alloy at a ratio such that of the total diffused copper and zinc less than 33% is zinc whereby a brass coating is formed over a copper coating.

Cathode Metal

U. S. Pat. 2,392,614. H. T. Prescott, assignor to Anaconda Copper Mining Co., Jan. 8, 1946. The method of producing a metallic cathode which may be broken relatively easily into a plurality of pieces of predetermined size which comprises preparing a cathode starting sheet having therein at least one slot of substantial width perforating the sheet and defining a line along which the cathode is to be breakable, said slot terminating short of the edge of the sheet, immersing said starting sheet as a cathode in the electrolyte of an electrolytic cell for the



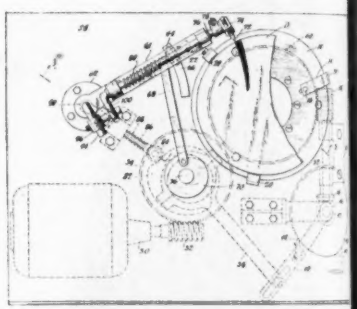
deposition of the metal, and depositing metal on the immersed surfaces of the starting sheet filling the slot and producing a relatively heavy cathode having at least one [illegible] of weakness where the deposited metal [illegible] the slot of the starting sheet.

Detergent Composition

U. S. Pat. 2,392,779. J. C. Showalter, [illegible] signor to Standard Oil Development [illegible] Jan. 8, 1946. A cleansing composition [illegible] paste form comprising a mixture of 20% [illegible] 35% of a heavy petroleum oil distillate [illegible] lected from the group consisting of lubricating oils and gas oils, 20% to 35% [illegible] sodium petroleum sulfonate, 20% to 35% [illegible] water and 20% to 30% of a finely divided [illegible] nonabrasive, absorbent material, the proportions of the several ingredients being [illegible] justed within the ranges given to total 100%.

Surfacing Polishing Disks

U. S. Pat. 2,392,654. J. Fine, Jan. 8, 1946. In combination with means for supporting a polishing disk and giving it a rotary movement about its axis, a mechanism for stripping the surface of such disk comprising means whereby the disk may be turned through 360 degrees about its axis, a cutting [illegible] pivoted outside the zone of the disk, a cutting point carried by the arm in such a way that when the arm is moved over the disk the point will move in a curving but approximately radial direction relative to the disk

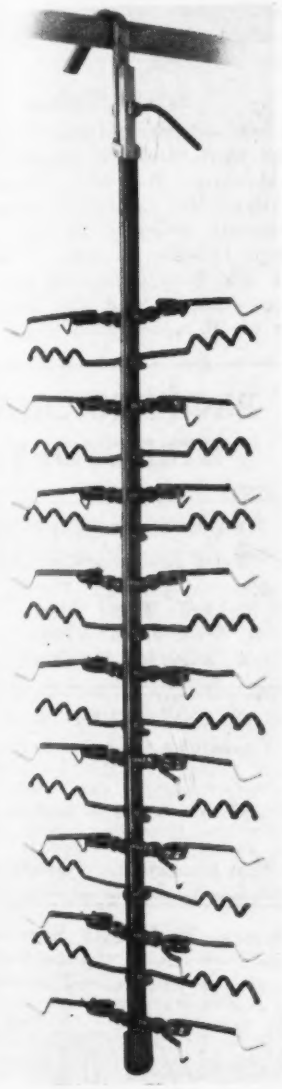


means for giving the cutting arm such movement over the disk, and means for pressing the cutting point against the face of the disk so that it will cut grooves in the surface of the disk.

Nickel Anodes

U. S. Pat. 2,392,708. H. E. Tschop[illegible] signor to The International Nickel Co., Inc. Jan 8, 1946. A process for producing nickel anodes containing sulphur which comprises immersing an anode and a starting sheet cathode in an aqueous electrolyte comprising essentially nickel ions, sulphate ions, chloride ions, borate ions and about 0.05 to 0.[illegible] gram per liter of alkali metal thiosulphate, said electrolyte being characterized by having the thiosulphate content thereof present solely as alkali metal thiosulphate, maintaining said electrolyte at pH of about 1.5 to 6.[illegible] and passing electric current at a cathode current density of about 5 to 100 amperes per square foot between said anode and cathode until a cathodic electrodeposit at least about 0.08 inch thick and containing about 0.007 to 0.11% sulphur is obtained, said cathodic electrodeposit being suitable in the as-deposited condition for subsequent use as an anode.

The New Standard Development of a MULTIPLE Service Plating Rack



No Other Plating Rack Can Equal The ADJUSTABLE EFFICIENCY of the "DU-ALL"

WHAT DU-ALL OFFERS

1—The rack adaptable for all standard solutions.

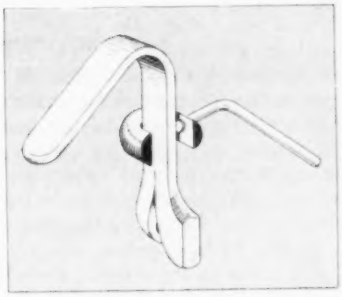
2—STAND IT ALL Flexible Insulation eliminates power and plating material losses and will not rob current.

3—Comparatively light in weight—but sturdily constituted for long life service.

4—DU-ALL with its wide range plating service will meet practically all of your plating requirements and give you uniform finish and thickness.

Top Hanging Hooks

The sample "DU-ALL" is furnished with two vertically adjustable copper top Hanging Cathode Hooks easily raised or lowered by a Combination Clamp and Handle, to permit facing the anodes as desired.



The Universal Rack is equipped with handle for easily removing to and from plating tanks.

SEND FOR YOUR ***DU-ALL*** *PLATING RACK TODAY*

STANDARD PLATING RACK CO.

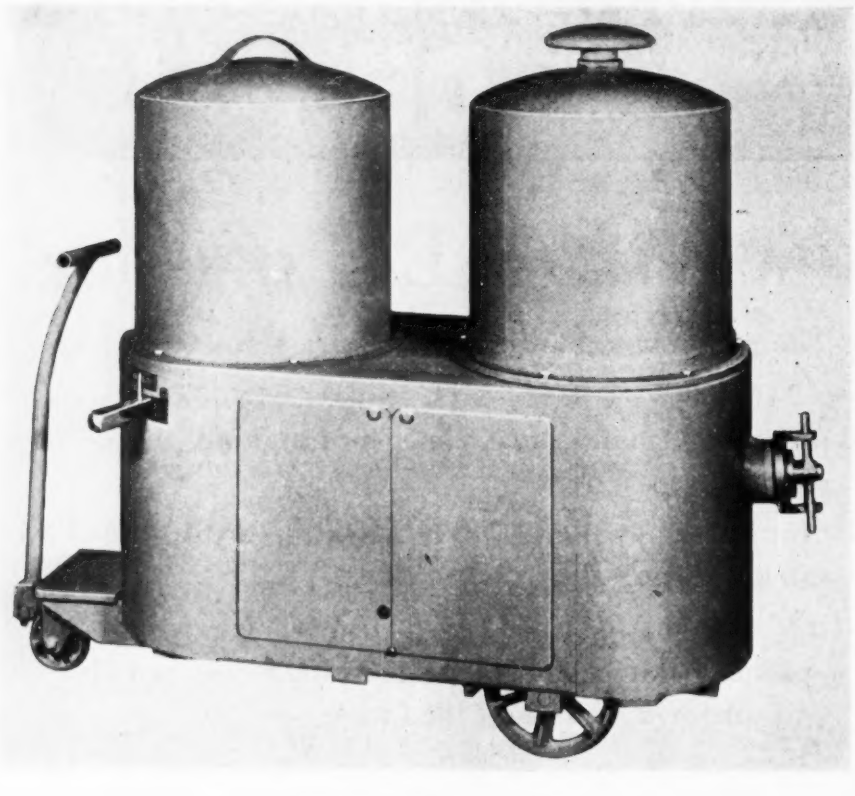
1913-1925 NORTH PAULINA STREET

CHICAGO, ILLINOIS

"The Largest Exclusive Plating Rack Manufacturers"

NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY



New Automatic Filter

The new Udylite Automatic Filter for plating room service incorporates a number of advantages not heretofore found in equipment of this type.

For instance, it may be used either for continuous or intermittent filtering. It serves to filter or transfer plating solutions easily and quickly without spilling any of the liquid. It requires no replacement parts. There is nothing to wear out and it can be cleaned without the use of a single tool.

The heart of this unit is a specially designed positive plug type multiport valve which has just one operating control lever. In other words, by manipulating this one lever one can prime the pump, feed slurry, backwash, build filter cake, clean the filter or transfer a solution from one tank to another. It is not necessary to change suction and discharge lines at any time after filtering has begun.

The filtering medium (activated carbon, diatomaceous earth or fibrous material) is mixed with water or plating solution in the slurry tank and transferred by the pump to the filtering tank.

The filter structure consists of rigid porous ceramic elements arranged radially with a central channel to carry the filtrate. These filtering elements are permanent and need not be renewed. The filter aid is deposited on the outside of these elements to form the filter cake. At any time during the filtering operation, filter aid can be added without interrupting the operation.

The entire unit is fully enclosed and easy to keep clean. It is also easily portable having truck wheels large enough and with sufficient tread to roll over duck boards easily.

Further information may be obtained by writing to The Udylite Corp., Dept. MF, 1651 East Grand Blvd., Detroit 11, Mich.

Floor Cleaner

Optimus Floor Cleaner No. 1F10 has been announced by Optimus Detergents Co., Dept. MF, 126 Church St., Matawan, N. J. This product is a heavy duty floor cleaning compound, especially compounded for use on cement, Terrazzo or tile floors.

Although very effective in removing oil, grease and other dirts from the surface, this material does not harm the finish in any way. In fact, regular washings with Optimus Floor Cleaner helps keep floors in good condition, makes them less porous, keeps them from dusting, keeps them whiter and cleaner.

Optimus Floor Cleaner is a base from which a liquid floor cleaner can be made, or it can be applied to the surface directly, and then rinsed off.

Used in lower concentrations, it is effective in industrial floor scrubbing machines.

Available in 150 lb. and 500 lb. containers.

Safety Siphon

A new and improved Safety Siphon of an inert plastic is announced by manufacturer, The Alden Speare's Co., Dept. MF, Cambridge, Mass.

Designed primarily for the safe efficient handling of acid, it is used draw acid from carboys of from 5 to gallons inclusive, and also from the bung of 50 to 55 gallon drums.

PROFESSIONAL DIRECTORY

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Metal Finishing Consultant
Problems in Automatic Plating, Electroforming and Plastic Plating; Plating Plants Installed.
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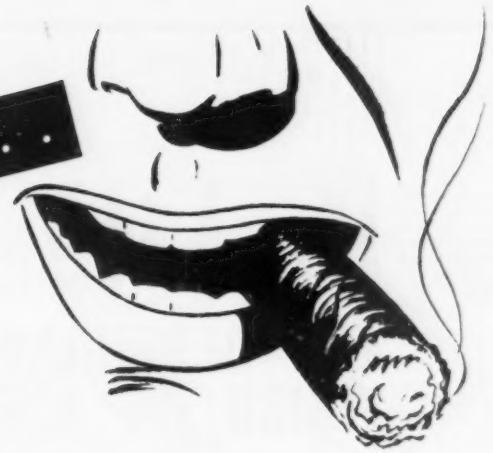
RE-CONVERSION AND PREPARATION FOR PEACE-TIME PRODUCTION: — *SPECIALIZATION*



"Lip service" is the kind that promises *much,* but actually delivers *little* . . .

The Diversey D-Man doesn't work that way . . . because his job has just begun when he has persuaded you to give Diversey products a trial.

Usually on the very day that Diversey drum or barrel ordered rolls into your plant, you'll find the Diversey D-Man on hand decked out in his overalls. And he'll stay on the job until he has fully instructed your plant men in the proper use of Diversey products or licked the problems confronting you.

A Trained Specialist

Yes, the Diversey D-Man is much more than merely a salesman. He's a *trained* specialist in the technique of preparing metal surfaces for further processing. Each new man joining Diversey is first given intensive classroom instruction . . . and he must pass his "final exams."

During his first few weeks in the field he is accompanied by an experienced D-Man . . . while his training continues indefinitely by correspondence and frequent "refresher" meetings. As a further check, practically all recommendations made in the field are confirmed by the Diversey Technical Service Department.

Service That Delivers Results

Yes, it takes this kind of "shirtsleeve and overalls" service to really deliver results. Any wonder more and more plants everywhere are looking to Diversey for *all* their metal preparation requirements? Metal Industries Dept., THE DIVERSEY CORPORATION, 53 West Jackson Boulevard, Chicago 4, Illinois.

DIVERSEY

Surface Preparation Service

FOR THE METAL INDUSTRIES

DIVERSEY PRODUCTS FOR CLEANING ALUMINUM

Diversey DC-36—For still tank cleaning of aluminum surfaces. Removes identification markings, heavy coats of drawing oil and grease quickly and safely.

Diversey S5—For still tank cleaning of aluminum castings. Quickly and completely removes surface contaminations.

Diversey DC-1—A non-toxic, non-fuming, dry powder developed to replace harsh, corrosive, and dangerous acids. Quickly and safely removes oxide films.

Diversey X-514—A cold deoxidizer for preparing aluminum alloys for spot welding. Produces low, uniform surface resistance.

Diversey X-511—A quick-acting stripper that completely removes anodize without attacking metal. Will not smut. Economical because of long life.

Diversey DC-30—A rapid acting etchant that leaves the aluminum surface with a uniform, light matte finish. Economical because of long life. Easy to use.

Du-Lite

THE DEPENDABLE BLACK FINISH *for* STEEL PARTS

There is a world of difference in black finishing processes. Experience and "know how" are not common to all. Chemical composition of the salts differ; procedures vary; and results are definitely not comparable.

But you can rely on the well-known Du-Lite Process with absolute confidence. It will blacken your steel parts uniformly, consistently and attractively—in regular volume production.

Du-Lite has succeeded where others have failed. And in every instance it has been because of the wide and varied experience and superior knowledge of the Du-Lite Engineer, as well as the easy workability of the Du-Lite Process. Du-Lite has specialized in steel finishing.

There is a Du-Lite Service Engineer in your territory and he will be glad to consult with you. Call or write Du-Lite at Middletown.

DU-LITE CHEMICAL CORP.

DEPT. A, MIDDLETOWN, CONN.

The Safety Siphon is easily and quickly primed by a built-in pump. Thereafter no further action is required. The entire contents of the carboy may then be discharged by the Siphon by manipulation of the flow control valve which may be adjusted from a tiny trickle to a fast steady flow. The plastic is unaffected by practically all grades of commercial acid.

3-Core Solder

Tri-Core, the solder with three independently filled cores of pure rosin flux is a new development of Alpha Metals, Inc., Brooklyn, N. Y. This new product offers users faster soldering and elimination of dry joints, in addition to substantial savings in tin.

A continuous supply of high grade noncorrosive rosin flux is always present in Tri-Core Solder, as the three cores are completely independent of each other. With these three cores, occurrence of "dry" sections in more than one core at a given point is mathematically unlikely, making Tri-Core more efficient and less wasteful than the usual single core solder.

Tri-Core offers the proper fluxing that is vital to good soldering. The arrangement of the three cores places them closer to the surface. Since the walls are thinner than those of single core solder, not alone does the solder melt more quickly, but the heat penetrates to the flux more rapidly, allowing it to flow freely and reach the work ahead of the molten solder.

Careful cross-sectional proportioning and the absence of surface seams prevent premature sweating out of the flux, making it clean to handle at all times.

Tri-Core solder exceeds A.S.T.M. Class A specifications and is available in all alloys, all flux percentages and all gauges. Bulletins and Engineering Test Samples are available from Solder Development Division, Alpha Metals, Inc., Dept. MF, 369 Hudson Ave., Brooklyn 1, N. Y.

New Cleaner

Wyandotte 97 Paste, the cleaner for washroom fixtures, floors and walls, is available in full flush, lock top steel drum like that shown in the photo. The handy and sturdy Wyandotte steel dispenser held by the young lady is also now available those who need them.

Wyandotte 97 Paste is a quick acting free rinsing cleaner. It is ideal for cleaning soiled painted furniture, for moving marks from floors of all kinds, for use by mechanics where hands be heavily soiled.

It is easy to get Wyandotte 97 Paste of either the small dispenser or the drum. As an added protection the inte of the large drum is enameled and the terior of the dispenser is varnished. steel dispenser and steel drum are equip with lock tops which assure the user a the quality put into 97 Paste in its manufacture.

The same pleasant odor which has found in Wyandotte 97 Paste since its ified introduction in 1942 is still maintain The pink color, the metal dispenser, and steel drum are new and are available to for the first time.

Further information may be obtained writing to Wyandotte Chemicals Corp., MF, Wyandotte, Mich.

Paint Remover

A new, remarkably fast, non-inflamma paint remover has been made available Kelite Products, Inc., Dept. MF, Los geles, Calif., makers of industrial clean compounds. This new material is safe any metal or hardwood surface and provi the speedy removal of all types of paint enamel. Its qualities make it valuable the metal industries. Its complete safety all metals, its non-inflammable characte tics and its speed meet all of the industry requirements. It is packed in 5, 15, or gallon amounts.

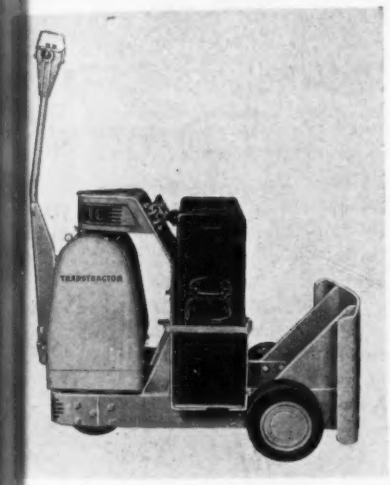
Probably the outstanding quality of Kel N. F. Remover is its amazing speed. P paratory tests, as well as recent reports h

...asized this. As many as 8 coats of ... can be penetrated, loosened and re... in one step, taking no longer than 30 ...tes. Unusual cases have been reported ... 22 coats were removed in three such ... Complete removal of one or two ... can be accomplished in 10 minutes. ...oval after penetration is easy in that ... or enamel can be sheeted off by a ...sure rinse.

...monstration will be gladly given by ... Kelite Service Engineer in your ter...y.

Electric Hand Truck

...e Transtractor, a new electric-propelled ... tractor developed by Automatic Trans...ation Co., Dept. MF, Chicago, brings to ...stry the combined features of an elec...propelled hand truck and the conven...al warehouse tractor. Answering indus...'s need for a small, but powerful, and ...euverable "push-pull" type materials ...ler, the Transtractor will push or pull ...000-pound trailer load all day or up to ...000 pounds intermittently, depending upon ... conditions. Finger-tip control enables



one man to handle any size or type of load with facility.

The Transtractor was designed specifically for applications in factories, warehouses, transportation terminals and storage plants requiring a towing type unit but demanding smaller and more maneuverable equipment than standard electric tractors. An addition to Automatic's line of electric-propelled hand trucks, the Transtractor utilizes the chassis, motor and controls of its brothers. It is equipped with a heavy duty bumper plate for pushing and a coupler is available for towing operations.

Non-Hazardous Bright Dipping

Waverly Petroleum Products Co., Dept. MF, Drexel Bldg., Philadelphia 6, Pa., has developed several Troxide bright dip formulae which are said to eliminate the serious hazards present in the conventional bright dip formula consisting of sulfuric acid and nitric acid.

The producer claims that many of the Troxide bright dips are less expensive than the conventional formula, a fact which is of importance to industry. Further information on Troxide bright dips will be furnished upon request.

Better cleaning of metal parts thru

MECHANIZED HANDLING

In your plans covering the production or maintenance cleaning of metal parts, a new complete line of OPTIMUS EQUIPMENT units offer your plant operating men a number of outstanding advantages.

These new OPTIMUS machines enable the combining of operations in one nearby sequence, they assist you in obtaining the best control of quality in your metal cleaning and allied process operations. "Rejects" can be lowered, bottlenecks eliminated, production speeded up, with their use.

If you are crowded for space, if you need to cut labor costs, eliminate needless "toting" of your metal parts — an OPTIMUS Plan for the mechanized handling of your metal parts through washing, rinsing and drying, can help you.

SEND FOR NEW ILLUSTRATED BULLETIN

An illustrated bulletin describing these new OPTIMUS Machines for metal parts cleaning is now in preparation, and will be sent to manufacturers interested in better handling of their parts cleaning operations. If you would like to receive a copy of the bulletin when it is ready, simply fill out and mail the coupon today.

OPTIMUS EQUIPMENT COMPANY

ENGINEERS AND MANUFACTURERS

127 CHURCH STREET, MATAWAN, N. J.

STANDARD AND SPECIAL TYPES OF EQUIPMENT FROM THE SMALLEST TO THE LARGEST SIZES FOR A WIDE VARIETY OF OPERATIONS

OPTIMUS EQUIPMENT

FOR WASHING · RINSING · PICKLING AND DRYING OF METAL PARTS

OPTIMUS EQUIPMENT COMPANY, 127 Church Street, Matawan, N. J.
Please send me a copy of your new Bulletin "Cleaning Metal Parts Before and After Finishing".

Name.....Position.....

Company.....

Company Address.....

City.....State.....

Mail this coupon with your company letterhead

in acrobatics it's balance

In metal cleaning, too, *balanced cleaners* are required.

The balanced composition of Wyandotte Metal Cleaners gives long life to solutions and permits lower concentrations, so that cleaning is economical. This balance makes Wyandotte compounds clean faster and more efficiently, resulting in economy through increased production and fewer rejects.

You get diversified applications from Wyandotte Metal Cleaners because of balanced formulas. They contain ingredients for water conditioning, saponifying, emulsifying, wetting action—plus the ingredients for a long pull. They give better rinsability.

Wyandotte Metal Cleaners give satisfaction in *all* cleaning—direct and reverse current cleaning of steel, brass, copper, magnesium, and die castings . . . still tank . . . presoak cleaning. They remove *any* soil from *any* surface in preparation for *any* finishing operation.

Let your Wyandotte Representative tell you more about the advantages of Wyandotte balanced Cleaners. He's always at your service. Just give him a call.

WYANDOTTE CHEMICALS CORPORATION • J. B. FORD DIVISION
WYANDOTTE, MICHIGAN ***Service Representatives in 88 Cities***

Wyandotte
REG. U. S. PAT. OFF.

Dry Chemical Fire Extinguis

This new extinguisher is designe combine high efficiency under most o tions with maximum protection to user and to equipment installations. A performs effectively under all climatic

ditions, in extreme temperatures, and the presence of winds or drafts.

All-Out Dry Chemical is ejected, u pressure, in a flat stream, that sepa the flame from the burning material, stantly forming a dense, fire smothe cloud over a flaming area up to a dista of 18 feet. All-Out creates an insula barrier between the operator and the fl providing protection from radiant heat. hot metal surfaces the Dry Chemical fo an insulating film, helping to guard aga dangerous re-flash.

This extinguisher meets the requirem of the Associated Factory Mutual Lab tories and Underwriters Laborato Product of Pressurelube, Inc., Dept. All-Out Fire Extinguisher Division, West 134th Street, New York 31, N. Y.

New Protective Mask

Recently announced by Mine Safety pliances Co. is a radically new develop in respiratory protection, the M. S. Chemox Oxygen Breathing Apparatus. apparatus, employing a replaceable chem canister, generates its own oxygen and g the wearer one hour's protection in breathable air. Weighing but 13½ lbs. c plete, and with no cylinders, high-press valves or fittings, the new Chemox Appara is ideally suited to the requirements of dustry and fire departments in meeting emergency where high concentrations poisonous gas or oxygen deficiencies encountered.

This outstanding achievement of M. S. research was perfected shortly before Pe Harbor and was immediately adopted by U. S. Government. The Mask underw continuous Navy battle service through the war, doing yeoman work in damage co trol aboard ship, with a wonderful rec

of damaged vessels kept afloat and many lives saved.

A unique principle is employed by the Mask to generate its own oxygen supply, operating independently of the outside air. For the first time in the history of science, this chemical combination in a simple canister creates oxygen—*by merely breathing into it.* Exhaled breath passes from the "All-Vision" Facepiece through the exhalation tube and into the canister where carbon dioxide is removed. Evolved oxygen flows into the breathing bag reservoir, then to the facepiece through the inhalation tube.

The M. S. A. Chemox Self-Generating Oxygen Breathing Apparatus is simple to use, and can be worn and operated without special training. It is quickly put on, and the replaceable canister does the whole job. Before the canister is exhausted, a pre-set alarm bell rings a warning to replace the canister with a fresh one. One of the most spectacular advances in safety progress, and time-proved under the most severe emergency service, the M. S. A. Chemox Apparatus is now immediately available for civilian use.

A descriptive bulletin on this outstanding M. S. A. Chemox Apparatus is now available on request, fully illustrating the apparatus and giving complete details of its operation. Copies of Bulletin BM-8 may be obtained by writing to Mine Safety Appliances Co., Dept. MF, Pittsburgh 8, Pa.

Air Separator

Under trade name Airfuge, a new separator for removing moisture, oil, scale, etc., from compressed air is announced by The Swartwout Co., Dept. MF, 18511 Euclid Ave.,

Cleveland 12, Ohio. Utilizing the centrifugal principle which has characterized steam and oil separators made by this company for 45 years, the new product features simplicity of construction and operation and highly efficient separation. Repeated tests show that air delivered by the Swartwout Airfuge is 99% or more free of contamination. Air entering the inlet is diverted positively to the inner wall of the round body and unwanted substances whirl out of the air stream and drain to the bottom. The cleaned air may be taken off horizontally or vertically from pipe-tapped ports. An integral float-operated trap releases condensate automatically. Separator is made of high-tensile iron; interior parts of corrosion-resisting materials. Bottom easily removed if necessary for cleaning. Made in three sizes for varying capacities and with a range of pipe connection sizes. Bulletin S-13 describes it.

FASTER AND BETTER . . .

INSULATION FOR PLATING RACKS

Throughout the plating industry MICCROTAPE and MICCROTUBE are recognized as unexcalled (1) for the protection of plating racks (2) for masking parts prior to selective plating . . . They are perfect insulators—easily applied—unaffected by cleaning solutions—economical to use.

◀ MICCROTAPE

An extruded tape with tapered edge (an exclusive feature) which permits much smoother overlapping, closer fit in grooves and around shoulders, making it particularly adaptable in hard chrome plating. Quickly applied—no heat sealing necessary. Has high dielectric strength, remains tough and permanently elastic.

MICCROTUBE

An extruded tubing with the same physical and insulating characteristics as Miccrotape. Speedily applied to straight and bent contact wires, also round splines which may be drilled later for contact wires. Used in conjunction with Miccrotape, the two being fused together to form a perfect leakproof coating. Available in inside diameters from $\frac{1}{16}$" to 1". ▼

Write for six page bulletin giving complete information and prices.

MICCRO Products

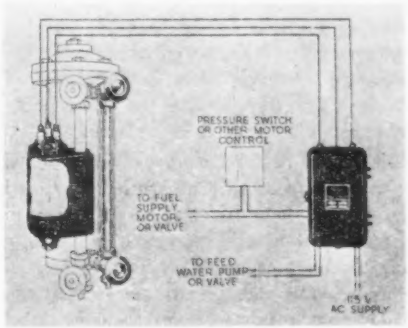
Manufactured and Developed by Experienced Platers

MICHIGAN CHROME and CHEMICAL COMPANY

6340 East Jefferson Avenue · Detroit 7, Michigan

Boiler Feedwater Control

Fireye Boiler Feedwater Control Type B177N is designed to provide fully automatic control for commercial and industrial boilers. It maintains desired water level through valve or pump control and instantly cuts off fuel supply and sounds an alarm



at a predetermined dangerous low-water level. It operates without any moving mechanical elements and the only contact with the boiler is through an auxiliary fitting containing metal probe rods which determine the control levels. Fireye requires no maintenance whatever because there are no moving elements and no vacuum tubes.

The probe fitting is mounted parallel to the water column and wired to the control. The probes within the probe fitting mark boiler feedwater pump on and off levels and a low water danger point. When water falls below the middle probe, Fireye closes the circuit controlling the pump and water feeds into the boiler until the top probe is reached.

The lowest probe defines the danger point below which boiler water must not fall. Should water drop below this safety probe, Fireye immediately shuts off the fuel supply and sounds an alarm.

Specifications:

Supply: 115-230 volts, 60 cycles A. C.

Output: 10 Amperes at 115 volts or 5 Amperes at 230 volts A. C. Relay contacts pure silver.

Drillet Box Jig Saves Up to 75% of Jig Body Expense and Labor!

The six-sided Drillet Box Jig above and at right has a range of 125 different sizes, making it possible to accommodate all sizes up to 6" capacity—for drilling, reaming, counter boring, counter sinking, spot facing, tapping, etc.

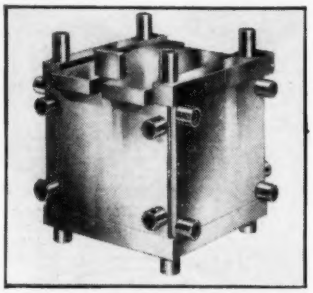
The Drillet Box Jig makes special tool design for drill jig unnecessary. Saves up to 75% of the time and cost of building a jig body. By merely turning thumbscrews and raising leaf, parts may be quickly loaded or unloaded. The jig may be used on all six sides, taking advantage of its full capacity.

Another useful product is chewing gum. You can enjoy chewing Wrigley's Spearmint Gum even while your hands are busy. The pleasant chewing helps to steady you—helps keep you alert and on your toes when you're doing a monotonous job.

Besides the satisfaction chewing gives you, it helps keep your mouth moist and fresh so you naturally feel better—and feeling better you work better.

Scores of industrial plants report that they have stepped up their workers' morale and efficiency by making chewing gum available to them.

You can get complete information from The Chicago Drillet Corporation, 920 S. Michigan Ave., Chicago 5, Ill.



Drillet Box Jig in Locked Position

AA-59

Non-Corrosive Rust Remover

A new rust remover has been perfected and a plant set up for its manufacture by the Nox-Rust Chemical Corp., makers of rust preventives. War-born research helped company chemists to develop successfully a product scientifically compounded to (1) wet metal thoroughly, (2) dissolve rust scale rapidly, (3) remove it completely, and (4) be relatively non-corrosive to steel even under conditions of long exposure.

This "selectivity" is claimed to be particularly pertinent to problems of removing rust from precision bearings and machined surfaces without affecting critical dimensions. Laboratory tests on highly polished roller bearings weighed to one ten-thousandth of a gram accuracy showed weight losses of less than one-twentieth of one per cent even after eight hours' immersion. Ordinary rust removal takes only a matter of seconds however, leaving no perceptible etching or discoloration of surfaces.

This new rust remover can be applied by usual methods such as brush, spray, and dip, but its long life and rapid action in otherwise inaccessible crevices make dipping the most economic wherever practical. Other uses, as widespread as rust itself, include rust removal from castings, steel stock, fabricated parts, hand tools, periodically idle farm and process equipment, sporting goods from guns to golf clubs, and government surplus items exposed to [illegible] thering during storage.

Rust Remover is available in [illegible] tankcar quantities. Further information [illegible] technical assistance are available on [illegible] from the Nox-Rust Chemical Corp., [illegible] MF, Chicago 8, Ill.

Instrument for Measuring Coating Thickness

The American Instrument Co., Dept. [illegible] Silver Spring, Md., announces the Film[illegible] NRL Model 1, a new electronic instrum[illegible] for measuring, rapidly and non-destructi[illegible] the thickness of paint, varnish, lacq[illegible] ceramics, plastics, and other non-conduc[illegible] coatings which may be deposited on [illegible] magnetic base metals such as aluminu[illegible] brass, copper, bronze, etc. The instrum[illegible] measures coating thickness from zero [illegible] 0.005 inch, with an accuracy of 3% of [illegible] scale, and measurements may be made [illegible] any flat surface, or on convex or conc[illegible] surfaces having a radius of curvature of [illegible] less than 6 in.

The Filmeter consists of a battery-operat[illegible] electronic beat-frequency oscillator contai[illegible] in a 7x7x7-in. steel case. The inductor [illegible] coil of one oscillator is mounted in the [illegible] of a tripod-mounted inductor, and is [illegible] nected to the instrument by means of [illegible] shielded rubber-covered cable. Earphon[illegible] enable the operator to determine when [illegible] two oscillators are set to the same frequen[illegible] The entire instrument weighs approximat[illegible] 11 lb., and may be used as a portable [illegible] instrument or on a laboratory bench.

Complete information is given in manu[illegible] facturer's Bulletin No. 88-2139.

Single Nickel Salts

The Harshaw Chemical Co., Dept. [illegible] 1945 East 97th St., Cleveland 6, Ohio, [illegible] developed a unique process which [illegible] makes it possible to produce single nic[illegible] salts in small definite crystals of carefu[illegible] controlled size and shape. These crystals [illegible] claimed to be the purest, highest nickel c[illegible] tent nickel salts ever produced by [illegible] company. Time and trouble in preparin[illegible] solutions are claimed to be saved due [illegible] the rapid solubility of the crystals. Furth[illegible] information may be obtained by writing [illegible] the company.

Face Shields

StaSafe Face Shields feature newly de[illegible] signed phosphor bronze spring retaining [illegible] clips which lock the visor firmly into po[illegible] tion. The simple operation of replacing [illegible] visors is done without tools or fasteners [illegible] merely lifting the retaining clip and slidi[illegible] the new front into place. This is a highly [illegible] desirable feature for it not only enables the [illegible] wearer of the face shield to get back on [illegible] job within a few seconds time but requires [illegible] a minimum amount of effort when changing [illegible] of the front is necessary.

StaSafe Face Shields are available [illegible] both the open top style No. 4 and [illegible] covered crown style No. 5.

Prices and complete details on request [illegible] Standard Safety Equipment Co., Dept. MF, [illegible] 232 West Ontario St., Chicago 10, Ill.

Business Items

Enthone, Inc., 442 Elm St., New Haven, Conn., has succeeded *Enthone Co.*, manufacturers of plating equipment and supplies. The company was operating as a partnership and the corporation has assumed all assets, liabilities and good will.

The officers of Enthone, Inc. are *Walter R. Meyer*, president; *J. F. Buckman*, vice-president and treasurer; and *Clarence C. Helmle*, secretary.

Dr. Walter R. Meyer

Dr. Meyer has been actively associated with Enthone since 1942, and was formerly editor of "*Metal Finishing*". Prior to that he spent seven years with the *General Electric Co.*, Bridgeport, Conn., as electrochemist and metallurgist.

Mr. Buckman was associated with the Enthone Co. since its founding and has been actively engaged in the finishing industry for the past 20 years.

Mr. Helmle has been with the Enthone Co. since 1943 and preceding that spent eleven years with the General Electric Co., Bridgeport, Conn., as chemical engineer.

Robert W. Kress of the Special Chemicals Division, *Pennsylvania Salt Manufacturing Co.*, has been promoted from assistant to *Joseph W. Manz*, senior sales serviceman in Chicago, to senior sales serviceman of the Northern Ohio area. He will make his headquarters in Cleveland.

The *International Nickel Company, Inc.* announces the recent opening of the St. Louis Technical Section of its Development and Research Division. It is located in Room 810 of the Ambassador Building, 411 North Seventh St., St. Louis 1, Mo.

The new Section, under the direction of *George A. Fisher, Jr.*, will furnish technical assistance in the territory embraced by the State of Missouri, southern half of Illinois, southwestern section of Iowa, northern half of Arkansas, western portion of Tennessee and States of Nebraska and Kansas.

Mr. Fisher graduated from Purdue University in 1935 with a Degree of Chemical Engineering. From 1935 to 1936 he was employed with the *Hurff Co.*, Swedesboro, N. J.; and from 1936 to 1939 he worked as a metallurgical and chemical engineer in processing control and research for the *Prest-o-Lite Company* of Speedway, Ind. Mr. Fisher then became plant metallurgist with the *Allison Division of General Motors Corp.* in charge of the Materials Laboratory which exercised technical control of all materials and processes. On November 16, 1945 he joined the Development and Research Division of The International Nickel Company, Inc.

This is the third new technical section which has been opened by The International Nickel Company in recent months. One was opened in Cincinnati on December 1, and another in Minneapolis on January 15.

At their meeting, held recently, the Directors of *P. R. Mallory & Co., Inc.*, Indianapolis, Ind., elected *Philip R. Mallory* chairman of the Board and *Joseph E. Cain* president. The action was taken at Mr. Mallory's request.

Mr. Cain is 42 years old and has been associated with the Mallory Company for 18 years. He has served the company as credit manager, treasurer and as vice-president and executive vice-president.

The *Westinghouse Electric Corp.* has announced the election of *Gwilym A. Price* as president, succeeding *George H. Bucher*, who has resigned from that office. Under a recent amendment of the corporation's by-laws, Mr. Price, as president, will be the chief executive officer.

A. W. Robertson, who as chairman has been the corporation's chief executive officer since 1929, has reached retirement age. He was elected chairman of the Westinghouse Board of Directors under the new by-laws and will continue as a member of the Westinghouse organization in a less active capacity.

THIS TYPICAL PLATING RACK
PERMANENTLY
INSULATED
and READY FOR USE in
LESS THAN AN HOUR!
Using Pen-Tape on the spline and Pen-Tube on the contact wires, plating racks are completely insulated in a matter of minutes, and can be used immediately when desired. This insulation will last as long as the racks themselves; for it withstands rough handling—remains tough and flexible—won't crack or oxidize in ANY plating bath, and completely resists high-temperature alkaline cleaning solutions.
Pen-Tape and Pen-Tube can be applied by anyone in your shop, require no extra floor space, and eliminate fire hazard. Over-all cost is less than that of any other insulating material.
On rush jobs, racks can be used as soon as insulated. For normal usage, the covering is fused into a smooth integral coating in just 20 min. at 275° F. Repairs become an integral part of the covering.
Elastic, flexible Pen-Tape is available in any width desired; standard width, ¾". Pen-Tube (the same material in tubular form) is furnished in sizes from 1/16" to 1" I. D. Illustrated bulletin gives full details; may we send you a copy?
Penkote
PRODUCTS
PENINSULAR CHEMICAL PRODUCTS CO.
6795 EAST NINE MILE ROAD
VAN DYKE • MICHIGAN

GE chooses Luster-on

Engineers at General Electric looked over the field and chose Luster-on* for the protective bright dip for zinc plated parts on their new 1946 radios. Read their statement — it tells the whole story of Luster-on superiority. Then send the coupon and a sample part for proof that you can see with your own eyes.

Here's What G-E Says . . .

We are using Luster-on on the chassis, speaker shells and other parts of our current radio line. Over and above the pleasing brilliancy of the finish, we find that with Luster-on we experience no difficulty in spot welding directly on finished surfaces, thus speeding production; and Luster-on affords protection from corrosion and salts formation to the parts treated, thereby promoting a greater expectancy of continued good service from our radios.

Paul L. Chamberlain
Manager of Sales
RECEIVER DIVISION

10

*Patent applied for

THE Chemical CORPORATION
54 Waltham Ave., Springfield 9, Mass.

THE CHEMICAL CORPORATION
54 Waltham Ave., Springfield 9, Mass.

Please send me full particulars about Luster-on* bright dip for zinc surfaces. I am (am not) sending sample part for free dip. No obligation, of course.

Name.....

Address.....

Metal Finishing, March

PERMAG
CLEANING COMPOUNDS

for Aluminum Die-Cast Metal Cuprous Metals and their Alloys

• PERMAG Cleaning Compounds rate high in efficiency. Their rapid cleaning action saves time. They maintain their strength longer, hence are more economical. They never injure soft metal surfaces.
These are a few reasons why PERMAG Compounds are used by an increasing number of metal finishing establishments.

Specially trained Technical Service men throughout the United States and Canada are ready to help you in metal cleaning problems.

MAGNUSON PRODUCTS Corporation
Mfrs. Specialized Cleaning Compounds for Industry
Main Office 50 Court St., BROOKLYN 2, N. Y.
In Canada: Canadian PERMAG Products Ltd., Montreal-Toronto

Gwilym A. Price

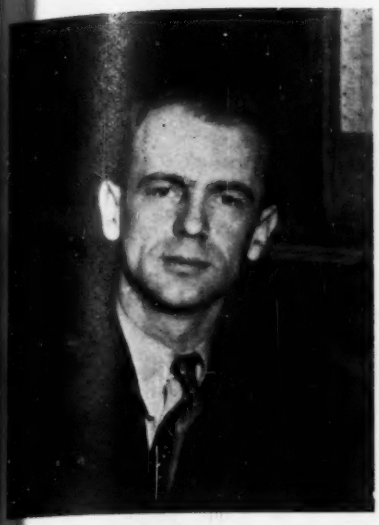
Mr. Bucher was elected vice chairman the Board of Directors and will continue serve as chairman of the Westinghouse Electric International Company, which handl all export business of the parent compa and will have other active duties.

At the age of fifty, Mr. Price is one the country's youngest directing heads a major corporation. He was elected a v president of Westinghouse in Septemb 1943, and had been executive vice presid since May, 1945. He was elected a me ber of the Corporation's Board of Direct in January, 1945.

Dave Blount

Dave Blount has rejoined the Mag *Chemical Co., Inc.*, of Garwood, N. J., assistant sales manager. Mr. Blount f Magnus in 1937 and has more recently be with *Red Star Yeast and Products Co.* I the past five years he has held the post bakery sales manager with the latter com pany. Extensive trade relation activit and frequent convention program appe ances have made Mr. Blount a famil figure in the baking industry.

Max Holscher, now on terminal le from the Army, has returned to the Scot *Sunbeam Corp.*, Saint Paul, as superinten ent of the Porcelain Enamel Plant.



Max Holscher

...ding to *N. H. Griebenow*, vice-president ... works manager.

Mr. Holscher was with the Seeger Refrigerator Co. before he was inducted into the Army in 1942. He later received a commission in the Armament Office, going to Italy in the Supply and Reserve Office. He is a graduate of the Ohio State University, Ceramic Engineering School Class of 1940. Prior to coming with Seeger in 1940 he had worked for the Florence Stove Company in 1935 and 1936, and Westinghouse Electric and Manufacturing Company, Mansfield, Ohio, in 1937 and 1938, where his duties were in the Mill Room and Control.

Raymond W. Goral

Raymond W. Goral of Bridgeport, Conn., will represent *Enthone, Inc.*, 442 Elm St., New Haven, Conn., manufacturers of plating equipment and supplies, in Southern Connecticut.

Mr. Goral received his Bachelor of Science degree from Teachers College of Connecticut in 1942 and did graduate study at the School of Engineering of New York University.

For the past four years he served in the Tenth Weather Squadron of the U. S. Army, spending most of his time in India and China, where he held the rank of Captain. Previous to this, he spent four years with Underwood Corp.

Stands Up Without Splitting or Chipping

Build up the required rack coating thickness with simple dipping and convenient air drying—both at room temperature. And the result is a tough, resilient insulation, well able to take the hard knocks of normal shop handling and repeated racking and unracking of work.

Specially formulated from improved resins, it resists to an outstanding degree the solutions and baths in the plating room. With Unichrome Rack Coating protection, in many shops 500 to 1000 cycles has become the common service life of racks. Write for free trial offer and learn first hand what a difference this rack coating can make in your shop . . . in economy, convenience and trouble-free service. *Reg. U. S. Pat. Off.

PROPERTIES

Chemical Resistance—Excellent for all plating cycles.

Toughness—Withstands repeated flexing and shop handling—cuts cleanly and easily at contacts.

Drying—Dipped in container in which it is shipped and dried at room temperature.

Adhesion—Excellent.

UNITED CHROMIUM, INCORPORATED
51 East 42nd Street, New York 17, N. Y.
Detroit 7, Mich. • Waterbury 90, Conn. • Chicago 4, Ill. • Dayton 2, Ohio

TRY THESE OTHER UNICHROME MATERIALS

Unichrome Coating 202—which is force dried for the extra adhesion required in anodizing and hot, highly alkaline solutions.

Unichrome Quick Dry Stop-Off 322—for cyanide copper and other plating work requiring extreme adhesion.

Unichrome Quick Dry Stop-Off 323—for chromium and other work requiring a stop-off that can be peeled off.

Unichrome Quick Dry Stop-Off 324—for high temperature solutions. It also resists vapor degreasers for a limited time.

Formation of a new $200,000 corporation to manufacture and sell specialized industrial coatings, lacquers and technical finishes was completed on February 1st by *Edward H. Christ* of New Britain, Conn. At the same time, Mr. Christ announced his resignation as vice-president, general salesmanager and a director of the *Stanley Chemical Co.*

The new company will be known as the *Chemical Coating Corp*, with general offices in New Britain. A new plant to fabricate the materials is planned for this locality immediately. The corporation has a capital stock of $200,000 and starts business with $100,000 paid in, according to incorporation papers filed with the Secretary of State.

Officers elected at the incorporation meeting are: President, *Edward H. Christ;* vice-president, *S. K. Hopkins*, Montclair, N. J., and *Edward D. Sechrest*, Wellesley Hills, Mass.; secretary and treasurer, *John J. Banninga*, Rutherford, N. J. Directors will be the officers and *Frank J. Wachter*, former vice-president of *Landers, Frary & Clark*, and *J. Lindsay Muir*, both of New Britain.

Mr. Christ was educated at Renssalaer Polytechnic Institute and was for four years Connecticut representative of *A. P. Munning & Co.* of Matawan, N. J. For the past twenty years he has been with the Stanley Chemical Co.

Mr. Christ is a member of the New Britain Board of Education and formerly served on the Common Council. He was a founder and the first president of the Exchange Club of this city and a member of the Shuttle Meadow Club.

INSULATION

Nothing equals BUNA-TOL as rack insulation in Decorative Plating.

Have you tried it?

NELSON J. QUINN COMPANY • TOLEDO 7, OHIO

As a step in its "plan for postwar expansion," *The Fidelity Chemical Products Corp.* of Newark, N. J., manufacturers of cleaning compounds, stripping compounds and detergents, announces the appointment of *John M. Guthrie* as technical director. Mr. Guthrie has been engaged in research and development work for the *Aluminum Company of America* and *The Bell Telephone Laboratories* for the past twelve years.

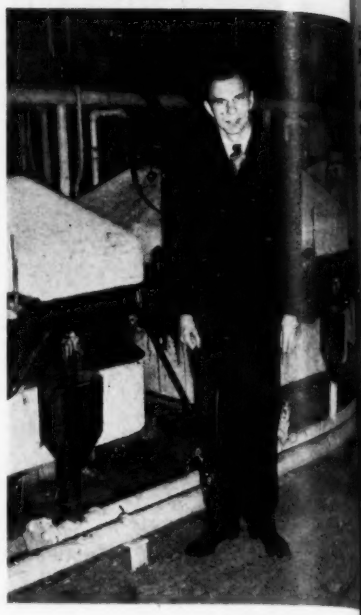
Fidelity has also appointed three new sales service engineers: *Allen A. Ainsworth* for Northern New Jersey; *Seymour B. Lonyai* for Newark and South Jersey; and *Abraham Schorr* for New York City, including the Bronx.

William R. Watson has returned to the *Pennsylvania Salt Manufacturing Company's* Special Chemicals Division after service in the Pacific as a Naval Lieutenant (j.g.).

Two trainees also have joined the Division. They are *H. Roper Davis*, who formerly worked for the *Fercleve Corp.*, Oak Ridge, Tenn., and *John W. Beaver*, recently discharged from the Army Air Force in which he served as a Lieutenant (pilot). Mr. Beaver formerly was with *B. F. Goodrich Co.*

L. E. Osborne, who joined Westinghouse at the age of 16 as a clerk in the tool room at the East Pittsburgh Works, recently was named senior operating vice-president of the *Westinghouse Electric Corp.*, responsible to the president for all manufacturing units of the company.

In announcing the appointment, *Gwilym A. Price*, president, explaining that Mr. Osborne's new responsibilities also include all subsidiary manufacturing companies as well as the District Manufacturing and Repair Department and the Headquarters Manufacturing Division of Westinghouse. His office is transferred to the company's Pittsburgh headquarters.



Dr. Glenn T. Seaborg

Dr. Glenn T. Seaborg, co-discoverer plutonium and elements 95 and 96, recen visited the plants of *Wyandotte Chemi Corp.* He was the guest of *Dr. Roy Heath*, manager of Industrial Sales of *J. B. Ford Division*, who was loaned Wyandotte Chemicals to join Dr. Seabo staff on the famous Manhattan Proje Dr. Seaborg, who was photographed Chlorine Cell Room No. 2, astounded hosts by stating that there is as m energy in a little more than half a po of plutonium as is derived from hundreds of tons of coal used each da the mammoth Wyandotte Chemicals pla

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Pemco Corporation of Baltimore has nounced additions to their customer se ice staff of *William Gladden* who cover the Midwest Territory and *Harold Giraud* who will cover the West Coast. Gladden, up to the war, had about 23 ye of service with Pemco, so he is not a "ne man. When last with Pemco, he was engineer in the service department.

Harold Giraud has just been released fr the Army. Entering the Service in March '41 he was sent overseas to the South Pa cific area and as Master Sergeant saw servi in Australia, New Guinea, Leyte, and Lu Previous to his entry into the service he w associated with the *Ed. Friedrich Manu facturing Co.* of San Antonio, Tex While with Friedrich his work covered eve phase of the porcelain enameling product with emphasis on millroom work, col matching, and control. The addition these two men to the Pemco staff is in keeping with their announced intention expanding every department of the co poration to adequately care for the rapid developing requirements of the trade.

Mr. Edward Magnuson, president *Magnuson Products Corp.*, manufacture of industrial cleaning compounds, announce the appointment of *Mr. George W. Dehn* sales manager. Mr. Dehn has been con nected with the cleaning, plating and finis

dustry, having traveled through the est for the past 20 years, representing apon Co., Division of *Atlas Powder* e will be located at the home office of agnuson Products Corp., at 50 Court rooklyn 2, N. Y.

Pennsylvania Salt Manufacturing Co. nced recently a company-financed re- nt program which will affect all yes, including hourly workers, in its and offices from coast to coast.

nard T. Beale, President, said the plan, diately effective, will provide for the ment of all employes, from officers at the age of 65, unless otherwise ically ordered by the Board of Di- s.

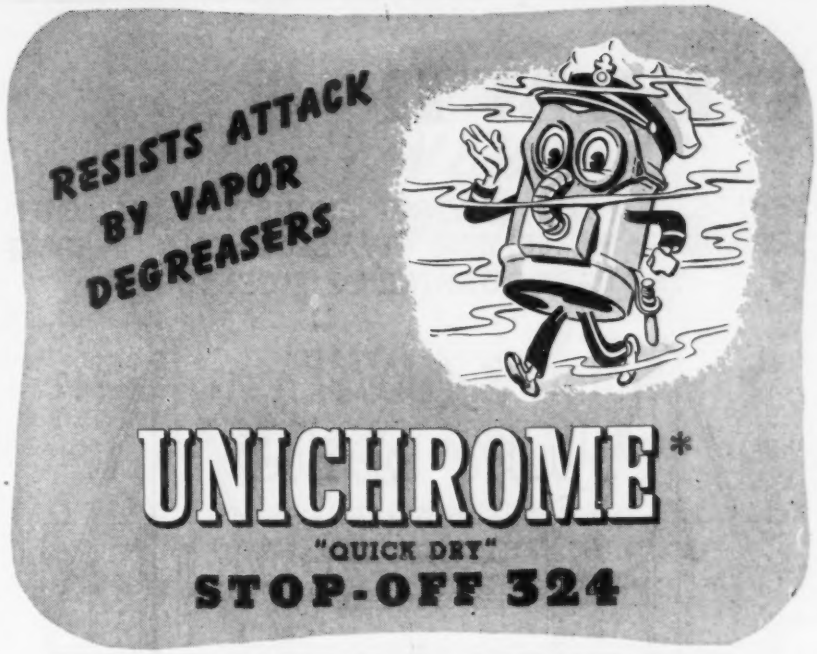
der the retirement benefit plan, em- s will be eligible for monthly payments e and one-half per cent of the highest al pay in the three years preceding ment, multiplied by the years of serv- The maximum monthly payments will 0 per cent of the highest annual pay an amount equal to Social Security fits.

Harry B. Higgins, president of the *Pittsburgh Plate Glass Company*, an- nced a broadening of the company's re- ment program for salaried employees. Under the new plan, more than 3,200 salaried employees, thirty years of age or over who have completed at least three years' service with the company, but who have not yet reached the retirement age of sixty-five, will be eligible for the retirement program.

Leslie Co., Lyndhurst, N. J., manufac- turers of regulators and controllers an- nounces the appointment of the following agents to handle industrial sales and serv- ice: *Walz and Krenzer, Inc.*, Rochester, N. Y., Mid-Western New York; *Gulf En- gineering Co., Inc.*, Savannah, Ga., South- eastern Georgia; *Robinson Electric Co., Ltd.*, Vancouver, B. C., Canada, British Co- lumbia.

Optimus Equipment Co., Matawan, N. J.,

Grover C. Schantz



Comes through the Most Severe Cleaning Cycles

Here's the fast-drying, air-drying stop-off to use for your most difficult plating conditions. It's an *unusual* development, so tough it will withstand even vapor degreasing, provided exposure time is limited. It has the adhesion required in hot cyanide copper and silver plating solutions, and electrolytic cleaners, but can be peeled off after plating.

Use any method of application—brush, dip or spray. When dry, you can define edges sharply, assuring clean-cut work. Why not see what a difference Stop-Off 324 can make in production time and quality? Write for free trial offer.

*Trade Mark Reg. U. S. Pat. Off.

PROPERTIES

Chemical Resistance—Excellent in all plating cycles.

Application—Can be brushed, sprayed or dipped—successive coating is minimized.

Drying—Dries quickly at room temperature—adheres without force drying.

Stripping—Removed from work with utmost ease immediately after plating.

UNITED CHROMIUM, INCORPORATED
51 East 42nd Street, New York 17, N.Y.
Detroit 7, Mich. • Waterbury 90, Conn. • Chicago 4, Ill. • Dayton 2, Ohio

TRY THESE OTHER UNICHROME MATERIALS

Unichrome "Quick Dry" Stop-Off 322—for high-temperature cyanide copper and other plating solutions.

Unichrome "Quick Dry" Stop-Off 323—for chromium plating and other solutions.

Unichrome Air Dry Rack Coating 203

Unichrome Force Dry Rack Coating 202

Unichrome Resist—a solid insulating material for constructing composite racks, etc.

engineers and manufacturers of metal washing and drying equipment, announces the appointment of *Grover C. Schantz* as production superintendent.

Mr. Schantz was previously plant superintendent at *Metalwash Machinery Co.*, Irvington, N. J. Prior to that he managed his own machine shop for several years, preceded by his holding the position of assistant master mechanic at *John A. Roebling Sons Co.*, Trenton, N. J.

Leonard T. Beale, president of the *Pennsylvania Salt Manufacturing Co.* recently announced the appointment of *James McWhirter*, as superintendent of Pennsalt's Natrona plant.

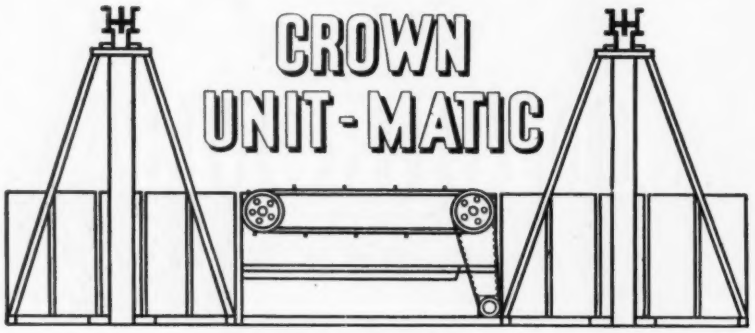
Mr. McWhirter, who succeeds *Charles G. Boone*, retired, came to Pennsalt last summer after eight years experience in the heavy chemical industry. Before joining Pennsalt in Philadelphia he had been superintendent of plants in Detroit and Cleveland for the *General Chemical Co.*

A native of Scotland, Mr. McWhirter came to this country as a boy. He earned his B. S. in chemistry at Middleburg College and M. S. in chemistry at New York University. He taught chemical engineering at both institutions on fellowships.

The *International Nickel Company of Canada, Limited* announces the formation of a Development and Research Section at 25 King Street West, Toronto, Canada. This section of the company will be staffed by *Dr. Gordon S. Farnham, A. S. Tuttle* and *H. J. Butterill*. The function of this Development and Research Section will be to extend to Canadian industry a complete consulting and technical service on metal problems. Naturally, it is particularly well posted on nickel and nickel alloys, their properties and field of usefulness. The

Crown

BRINGS TO THE PLATING INDUSTRY THE OUTSTANDING EQUIPMENT DEVELOPMENT DURING THE PAST QUARTER OF A CENTURY



(PATENT APPLIED FOR)

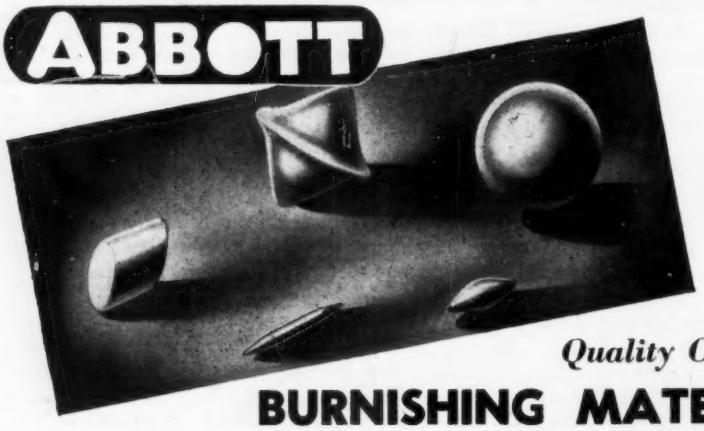
FULLY AUTOMATIC
PARTIALLY AUTOMATIC
EQUIPMENT

FOR

PLATING
ANODIZING
CLEANING
PICKLING

CROWN RHEOSTAT & SUPPLY CO.
3465 N. KIMBALL AVE. CHICAGO, ILL.

ABBOTT



Quality Controlled

BURNISHING MATERIALS

Want a sample kit of materials?

There's more than seen on the surface—Abbott Burnishing Materials . . . Balls, Pins, Slugs, Cones . . . are given the proper heat treatment to provide the all important "backbone" necessary for an efficient job of Burnishing . . . Abbott Materials are quality controlled! Lower your finishing costs—use Abbott Materials!

THE ABBOTT BALL COMPANY 1046 NEW BRITAIN AVE. HARTFORD 10, CONN.

Canadian Section will be closely with and have available to it, the fac and broad experience of the United and British Divisions.

Gordon S. Farnham, Ph.D. (Manches B.A., M.Sc., (Queen's), has, most rec been Chief Metallurgist, Departme Mines, Ottawa, and has gained an national reputation in the metallurg iron and steel.

A. S. Tuttle, B.Sc. (Mechanical gineering), was for three years with Engineering Department of Canadian inghouse and, more recently, with Metals Control, Ottawa.

Major Butterill, B.A.Sc. (Metallur Engineering, Toronto) was until rec Chief Design Officer, The British Mi of Supply, on light anti-aircraft guns rockets.

The Development and Research Se will welcome questions relating to the of metals and alloys, particularly w strength-weight ratio, corrosion, erosion, high or low temperatures are involved.

R. W. Boettiger

Russell W. Boettiger has been appoint sales manager of *Leslie Co.*, Lyndhu N. J., manufacturers of regulators and trollers. Mr. Boettiger, a graduate of chanical engineering at Cornell Univers joined the Leslie Organization in 1936 sales and service engineer. Prior to t he was in plant engineering with *Gene Foods Corp.*

In 1942, he was appointed chief plant engineer in charge of co-ordinating prod tion with the stringent requirements of wartime shipbuilding program. In his position, Mr. Boettiger will supervise field sales and service activities of Le agents.

Appointment of *William L. Platt* as sa representative for the *Columbia Chem Division* of the *Pittsburgh Plate Glass* was announced today by *W. I. Galliher*, ecutive sales manager for the division. Platt will be located at the company's fices, 300 Babcock St., Boston, Mass.

Mr. Platt is a graduate of Purdue U versity, class of 1927, with the degree

B.S. in Chemical Engineering. Prior to his appointment to the Columbia Chemical Division in 1930, he was associated with the company's Glass Division. During his 16 years with the Columbia Chemical Division, he has specialized in industrial engineering and in various phases of the production of heavy chemicals.

W. C. Brate Company, manufacturers of bright nickel process are now located in a new and larger factory at 14-16 Market St., Albany 7, N. Y.

The *Electric Products Co.*, 1725 Clarkstone Rd., Cleveland 12, Ohio, announces the addition of *Robert H. Ehret* to the headquarters sales staff. Mr. Ehret will be responsible for handling headquarters sales negotiations.

Mr. Ehret brings to his new position a broad experience in electrical sales and engineering gained from 1½ years training with *General Electric Co.* and *Electric*

Robert H. Ehret

Machinery Manufacturing Co., plus 11 years selling, applying and installing apparatus manufactured by the *Burke Electric Co.*

Eight additional researchers have joined the staff of almost 100 at the *Pennsylvania Salt Manufacturing Company's* Whitemarsh Research Laboratories in the expanded post-war research program under *Dr. S. C. Ogburn, Jr.*, Pennsalt's manager of research and development.

The new staff members are *Dr. Martin Leatherman*, a former Major in the Chemical Welfare Service Technical Command; *Robert H. Tiers*, formerly with *Pratt and Whitney Aircraft Corp.*; *Dr. W. J. Knapp*, formerly with *North American Cement Co.*, and recently in the U. S. Navy; *Glendon B. Kyker*, formerly with *Hooker Electrochemical Co.*; *H. A. Kraftson*, formerly with *E. I. duPont deNemours Co.*; *Frederick D. Loomis*, recently released from the U. S. Army; *Peter Zappasodi*, chemist at Pennsalt's Philadelphia plant; and, *E. J. Nolan*, formerly with *Rohm and Haas Co.*

Dr. Leatherman, who has a wide back-

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ground in textile research, will be in ch of development and evaluation of and improved textile chemicals at W marsh.

Mr. Tiers will be in charge of Special Chemicals Sales Service La tory and development work in new and proved metal cleaners and related mate

Dr. Knapp, a graduate of New Y State College of Ceramics and the M chusetts Institute of Technology, will w on development and evaluation of cera chemicals

---

Charles Davidoff has opened offices laboratories at 198 Broadway, New York N. Y., where he will specialize in chemi and metallurgical investigations. He w formerly vice president in charge of che cal engineering at *Sam Tour and Co.*

News from California
By FRED A. HERR

Marking the first appearance in South California of a president of the *Supre Society* since the visit to Los Angeles *Frederick Fulforth* some five years ago, t 1946 annual Educational Session of L Angeles Branch, A.E.S., March 23 will featured by the presence of president *W. Pinner* of Detroit, Mich.

The program has been scheduled in form of morning and afternoon busine sessions, a noonday luncheon and the ann banquet and ball in the evening. The loc tion will again be the Los Angeles Bre fast Club where a number of the branch previous annual affairs were held.

President Pinner is scheduled to make tw talks. At the morning session he will dis cuss "*Progress and Activities of the Ame can Electroplaters' Society*," and at th afternoon session he will give a talk "*High Speed Nickel Plating*," along th lines of the discussion which won mu favorable comment when Mr. Pinner pre sented it at the recent annual session Chicago Branch.

Other speakers and their subjects an nounced by *M. D. Rynkofs*, chairman of th arrangements committee, are:

R. D. Hull of the Hull Co., "*Electro Plating, Past, Present and Future.*"

E. R. Lyons, the Meaker Co., "*Corrosi and Salt Spray Tests on Single Deposits Steel.*"

William Jackson, Barrel Plating Depar ment, Udylite Corp., on "*Plating Barre and Cylinders.*"

There will also be a factory demonstrati on the technique of plating records by representative of the Olympic Co., Lo Angeles.

Because of the limited floor space fo tables available at the Breakfast Club, mem bers of the A. E. S. are being given priorit on reservations before tickets are being mad available to the general public.

Chief Products Co., Los Angeles, manu facturers of kitchen utensils, fish fryers, flap jack turners, pancake tins and related items, has initiated a modernizing program for its plating and finishing department involving

the acquisition of some $50,000 worth of additional equipment.

Carroll McLaren, plating room foreman, disclosed that the plans call for installation of a new full-automatic plating setup capable of handling some 40,000 pieces a day, modernization of burnishing equipment by the addition of late model barrels, and acquisition of miscellaneous other equipment. Sufficient space is available in the present plant to make erection of a building addition unnecessary, Mr. McLaren reported.

Da-Lite Chemical Processes, Los Angeles, is installing additional equipment in the form of five 450-gallon tanks and cleaners for work with steel, copper, copper-alloy, aluminum and zinc, *John Bowman* and *A. J. Ahlschlager* reported in February. Items now being worked by the firm include radar and gun parts, automobile parts, nail files, cuticle scissors, ashtrays, etc.

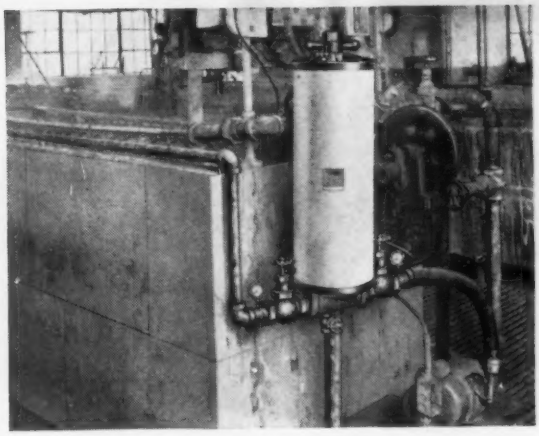
Robert S. Burrill, formerly with *Baby Darling Products Co.*, has established himself in business at 117 West Eighth St., Los Angeles, under the firm name of *Baby Memoirs*, for plating and metal spraying baby shoes. Temporarily, Mr. Burrill is having the factory work done by outside shops but expects later to establish his own shop. He plans to use bronze as the principal finish on baby shoes and to offer also a pink-and-blue pastel finish using a combination plastic and lacquer compound. Spray and dip methods will be used. *Roy J. Kane* has been named as office manager. Mr. Burrill has engaged a staff of three salesmen but eventually expects to increase it to thirty for house-to-house solicitation in Los Angeles and environments.

R. D. Dau, president, *Lasalco, Inc.*, St. Louis, accompanied by *Mrs. Dau*, arrived in Los Angeles for a month's business and pleasure visit on February 4. They spent the first week at Laguna Beach, Calif., and planned to remain in Los Angeles for about three weeks to enable Mr. Dau to renew contacts with the trade.

This columnist is pleased to report the complete recovery of *Ernest Lamoureux* from the serious heart ailment which confined him to his Los Angeles home under a nurse's care during the early part of January.

Stanley Rynkofs of the *Liberty Plating Co.*, Hollywood, attended his first A. E. S. meeting in nearly 1½ years on February 11. He was discharged Christmas week after 16 months service in the Navy during the greater part of which time he was attached to Naval Intelligence at Pearl Harbor. He is back on his prewar job now and also busy, with his father, *M. D. Rynkofs*, in making plans for the spacious new plant for Liberty Plating Co. which is expected to get into construction soon.

E. S. Waldbott, chief metallurgist at the Long Beach, Calif., plant of the *Douglas Aircraft Co.*, has been appointed a process engineer and will handle his new duties simultaneously with his post as chief metallurgist.



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Associations and Societies

American Electroplaters' Society

Milwaukee Branch

The Milwaukee Branch of the A.E.S. is again holding its Annual Educational Meeting and Banquet at the Schroeder Hotel on April 20, 1946.

The speakers for the Educational Meeting to be held at 2:00 P. M. are *W. L. Pinner*, President of the *A.E.S.*, *Dr. R. Saltonstall* of *Udylite Corporation* and *Dr. Walter Meyer* of the *Enthone Company*. Their subjects will be announced later.

Fred Anderson, Chairman
Publicity Committee

Los Angeles Branch

Michael Raskin of the Rainbow Processing Co., Los Angeles, presented a talk on "*Electroplating on Aluminum and Its Alloys*" which provoked considerable open forum discussion at the February 11 meeting of Los Angeles Branch, *AES*, in the Cabrillo Hotel, Los Angeles.

Mr. Raskin's experience covering five years plating aluminum parts in Southern California aircraft plants gave him an authoritative background for capable presentation of the controversial subject of aluminum plating.

His talk, he explained, represented a combination of information he gained during his personal experience with aluminum plating and data he had assembled in recent research into the subject.

Mr. Raskin pointed out that aluminum possesses features not found in magnesium and has the additional advantage of being light in weight, readily adaptable to machining, plus good density and castability.

He declared that the principal reason for plating aluminum is to improve the appearance and that it can be given finishes ranging from a matte finish to a satin finish.

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He conceded, however, that plated alu... does not have a comparable eye... of some other metals but has a numb... advantages for use on parts on w... "dressy" appearance is not essential.

The speaker then presented a step-by... explanation of the process of alum... plating, starting with racking practic...

On pre-treatment, he said that pres... ment in plating aluminum is of ex... importance. The part must not onl... *physically* clean but also *chemically* ... he emphasized. To accentuate this ... more strongly, Mr. Raskin declared ... whatever methods of cleaning are use... other types of plating, the technique s... be tripled when aluminum is involved.

Branch President E. W. Wells pre... at the business session of the meeting ... visitors were introduced: *B. D. Dau*, p... dent, Lasalco, Inc., St. Louis; *B. C. Bar...* Chrome Process & Engineering Co.; *... Warner*, Los Angeles Plating Co.; *A... Ahlschlager*, Du-Lite Chemical Prod... *Paul Smith*, Hallenscheid-MacDonald ... *E. E. Hamor*, U. S. Army; *Clyde T...* Standard Oil Co.; *Edward Noren*, Me... Chemical Co.; *J. D. Millhorn*, Me... Chemical Co., and *S. W. Mashburn*, ... gressive Plating Co.

Six new members were initiated: *Ge... A. Simpson*, Advance Plating Co.; *... Thiene*, Electro-Plastic Processes; *Ro... Kaas*, Russill Plating Co.; *William Tr...* Bowers Mfg. Co.; *John F. Drake*, Ken... & Drake; and *A. J. Ahlschlager*, Du... Chemical Products.

The Branch voted to intensify its ... for sustaining memberships for the Soci... Society, starting with the mailing o... follow-up letter to the prospects who ... been contacted by letter previously.

Upon suggestion by Secretary Tr... Bunker it was decided to launch a spe... drive through the membership commi... to contact members discharged from ... armed services who have not, as yet, ... associated themselves with the branch. T... secretary reported that approximately ... dozen or so who were active in the bra... before entering the service had not ... sumed membership and should be g... attention.

M. D. Rynkofs, chairman of the ... rangements committee, announced the co... pleted program for the annual educati... session and banquet.

Newark Branch

The annual Spring open educati... meeting is scheduled to be held on Apri... at 7:30 P. M. at the Robert Treat Ho... in Newark, N. J.

This is the third of a series of th... open meetings sponsored by the New... Branch yearly. The Branch is deeply gr... fied by the excellent attendance by mem... and friends at these meetings in the pa...

In an earnest desire to furnish as m... valuable information as may be obtai... on the subject of electroplating the co... mittee has again obtained three outstandi... speakers who are well qualified to pres... their well chosen and interesting subje...

The speakers and subjects to be presen... are as follows:

Myron Diggin, of *Hanson-Van Winkle-Manning*, Matawan, N. J., Subject: To be announced; *M. R. Murliss* of *Monroe Calculating Machine Co.*, Subject: Finishing of Steel; and *Dr. G. K. Soderburg of Graham, Crowley & Associates, Inc.*, Subject: Evolution of Plated Coatings.

It is hoped that all members and friends will be on hand April 5 to spend an interesting and educational evening in the friendly atmosphere of the Newark Branch.

Educational Com.
William Bruhns

Twin City Branch

The Twin City Branch of the American Electroplaters' Society met Monday, February 4th at the Covered Wagon Lodge Room in Minneapolis. The business meeting which followed dinner, was called to order by President *Paul W. Felt* at 8:00 P. M. Mr. Felt introduced the following guests who were present: *Mr. Merrill* of Chicago, Ill., *Mr. Edson Bernish* of Minnesota Plating Works of Saint Paul, Minn., *Mr. Bill Phelps* of Ruehle Plating Co., Minneapolis, *Mr. Reg. Lohmann* of V & L Metalcraft, Minneapolis, *Mr. Jorgenson* of Minneapolis Honeywell. *Mr. W. J. Miller* and *Mr. R. W. Slaney* of Detrex Corp., Minneapolis.

The door prize for the February Meeting was an Eversharp Pen donated by the Branch and was won by *Mr. Ben J. Rosenthal* of Wyandotte Chemical Corp.

Following the awarding of the door prize, the Secretary-Treasurer's report was given which was approved as read. *Mr. Gordon W. Lillicrop*, Membership Chairman, then introduced new members. They were *Mr. Howard J. Hawkins* of Hawkins Chemical Co., Minneapolis and *Mr. Paul J. Kluber* of Northern Ordnance, Minneapolis. Mr. Kluber transferred from the Milwaukee Branch. President Felt then called for the committee reports. *Mr. E. H. Lindemann*, Chairman of the Research Fund Committee, stated that his committee was calling on several of the possible Sustaining Members from whom the committee had received no response. *Mr. Gunner Deedon*, Chairman of he Convention Exhibits Committee, stated that his committee was closely following their task and that they would have a detailed report for the March Meeting.

President Felt, following the Committee Reports, stated that the Board was following each meeting closely in planning their programs so that each paper will be different and follow an interesting trend.

Following a short recess, the speaker for the meeting was introduced. He was *Mr. J. W. Dammers* of G. S. Blakeslee Company and his paper was "Vapor Degreasing." Mr. Dammers' paper was both informative and interesting. Following questions from the members, the meeting adjourned at 10:00 P. M.

Robert I. Buckley, Secy.-Treas.

Chicago Technical Societies Council

The *Chicago Production Show*, sponsored by the *Chicago Technical Societies Council*, will be a "sell out" according to advance

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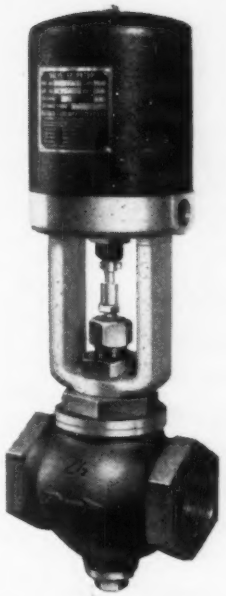

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Valuable Reference Books

Electroplating by Field and Weill, 1945 edition, 483 pages, $5.00. The chapter headings are as follows: Fundamental Principles, Electrolysis, Faraday's Laws, Principles of Chemical Analysis of Electrodepositing Solutions, Some Materials Used in Electroplating, Sources of Current, Properties of Electrodepositing Solutions, Electroplating Plant, Mechanical Cleaning, Chemical Cleaning, Deposition of Copper—The Acid Bath—Alkaline Baths, Silver, Gold, Nickel (2 chapters), Zinc, Cadmium, Chromium, Various Metals, Deposition of Alloys, Testing of Electrodeposits, Allied Processes, and Metal Coloring.

Modern Electroplating, 1942; 400 pp. Price $6.00 including service and postage. Prepared by various experts and supplied with many references. Provides a comprehensive survey of modern practice. The opening paper describes general principles and methods. Succeeding material deals with the various metal coatings and the solutions from which they are produced.

Electro-Deposition of Metals by G. Langbein and W. T. Brannt, 9th ed.; 1924; 875 pp. Price $7.50. The "master treatise" on electroplating, galvanizing, metal coloring, lacquering and electrotyping. Covers the history and theory of metallurgy as well as its practical applications with a minimum of technical terms.

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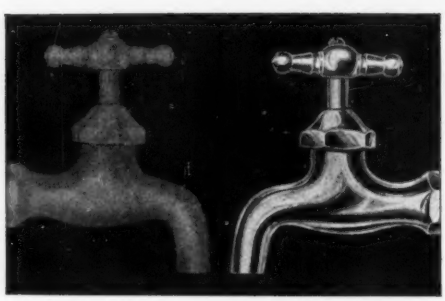

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indications. The show will be held in the Exhibition Hall of the Stevens Hotel, Chicago, March 20, 21 and 22, concurrent with the Council's Annual Conference.

Emphasis will be on new advances in departments of industrial production, tools, materials, instruments, and miscellaneous equipment.

Free tickets of admission to the show may be obtained by any manufacturer on application to the Council headquarters, 53 West Jackson Blvd., Chicago, or to any of the 47 participating scientific, engineering and technological societies, which include all those in the metal working and finishing fields.

Registrations are being accepted now for the 48 panel sessions which will comprise the Conference. Theme of these sessions, as of the Production Show, will be *"Production for Profit"*; speakers will include nationally known authorities in nearly every field of science and technology. This three-day conference is expected to give sharp impetus to reconversion in Chicago and the Middle West.

Manufacturers may make advance reservations for the panel sessions on behalf of all or part of their supervisory personnel down to and including foremen. Such requests should go, as above, to the headquarters of the Council or to any of the affiliated societies. Advance registrations for the three-day Conference are at $2 each; registration fee at the time of the Conference will be $3 per person.

Obituaries

Joseph Barron

Joseph Barron, assistant sales manager of the *M. E. Baker Co.*, Cambridge, Mass., died suddenly at his home on February 11th. His death was due to a coronary thrombosis.

Mr. Barron had been associated with the

Joseph Barron

S. E. Baker Co. since 1934. He was a member of the *American Electroplaters' Society* and was the General Chairman of the Boston Convention in 1941.

Mr. Barron is survived by his widow, the former *Eve Baker*, and three children.

Joseph Holland

Joseph Holland, president of *J. Holland and Sons, Inc.*, 274 South Ninth St., Brooklyn, N. Y., died on February 22nd, 1946.

Joseph Holland

Mr. Holland's wife *Clara* preceded him in death by three weeks to the day. Mr. Holland entered the electroplating field in 1905. J. Holland and Sons, Inc., was established in 1926.

Mr. and Mrs. Holland are survived by four daughters and three sons, William, Louis and Charles.

James W. Higgins

James W. Higgins, assistant chief metallurgist of the *Packard Motor Car Co.*, died on February 17, 1946. He was a past president of the *Detroit Branch* of the *American Electroplaters' Society* and had been active in the society over twenty years.

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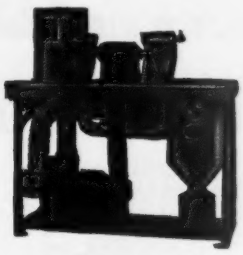
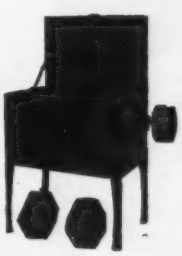
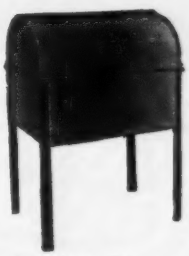


Polishing Bench

Dryer



Tubbing



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Manufacturers' Literature

Protective Coating

United Chromium, Inc., Dept. MF, 51 East 42nd St., New York 17, N. Y., has recently issued a twelve page booklet describing and illustrating *Ucilon Protective Coating*. Ucilon is a new plastic base material which is claimed to resist all acids in commonly used concentrations. It resists all alkalies and salts at ordinary temperatures, as well as petroleum derivatives and natural oils. In addition, it is non-toxic, non-conductive, inhibitive to fungus.

Your New Laboratory

Behr-Manning Corp., Dept. M. F., Troy, N. Y., has issued a new booklet entitled, "*Your New Laboratory*," which is both an announcement and an invitation.

It announces centrally located branch office demonstration laboratories for customer use in pre-testing abrasive methods and equipment.

It invites you to share the benefits of this new "convenience engineering" as they apply to your product or your production problems.

Copies are available by writing to the company at the above address.

Filters

Filtration Efficiency is the title of a new folder issued by the *Commercial Filters Corp.*, Dept. MF, 19 West Third St., Boston 27, Mass. This folder describes and illustrates the Fulflo Filter manufactured by the company.

Copies of this folder may be obtained by writing to the company at the above address.

Electrocleaning

Mac Dermid, Inc., Dept. MF, Waterbury 88, Conn., has recently published a data sheet on a new product for the electrocleaning of copper buffed articles prior to any finishing operation. This data sheet gives typical cleaning cycles for the proper cleaning of any copper coated article.

Cleaning

Of increasing interest to plant superintendents and others responsible for machinery and equipment maintenance cleaning are the savings in time, money and effort being effected by steam detergent cleaning methods. A booklet on this subject has been published by *Oakite Products, Inc.* and is available free upon request.

Described in this booklet are many applications of steam detergent cleaning for (1) cleaning machinery equipment and parts for subsequent repair and overhaul, (2) preparing equipment surfaces for repainting or refinishing, (3) cleaning equipment too large for tank immersion, or where suitable tanks are not available, (4) paint stripping. Emphasis is placed on steam detergent cleaning as a simple, fast method for safely removing grease, oil, dirt, and other deposits from all types of equipment through the combination of mechanical force, controlled heat and effective detergent action of recommended materials. Savings of nearly 50% of former costs and over 75% of time and effort are reported on some cleaning operations using this modern method.

Write to Oakite Products, Inc., Dept. MF, 18 Thames St., New York 6, N. Y., for a free copy of their booklet on "Steam Detergent Cleaning."

Finishing Wheels

A bulletin describing Manhattan's new Engineered Finishing Wheels, now available in several resiliencies with a synthetic rubber bond, has been issued by Manhattan *Rubber Division of Raybestos-Manhattan, Inc.*, Dept. MF, Passaic, N. J. Copies may be obtained by writing the Abrasive Wheel Department for a copy of Bulletin No. 6881-A.

Important features claimed for these finishing wheels, manufactured exclusively by Manhattan under U. S. Patents 2,122,[illegible] and 2,255,891, are described in the bulletin. These features include cushion action, uniform performance, versatility, etc.

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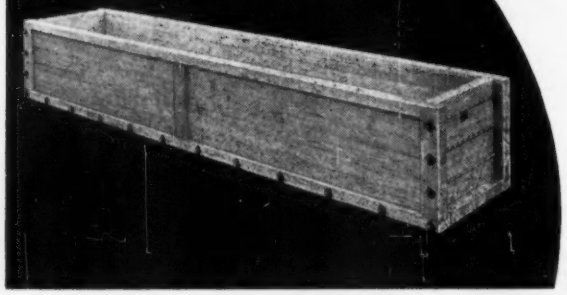

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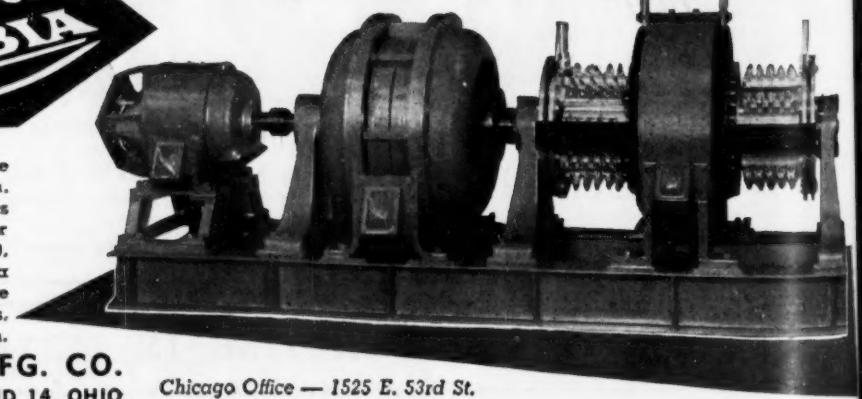
MOTOR GENERATORS by COLUMBIA

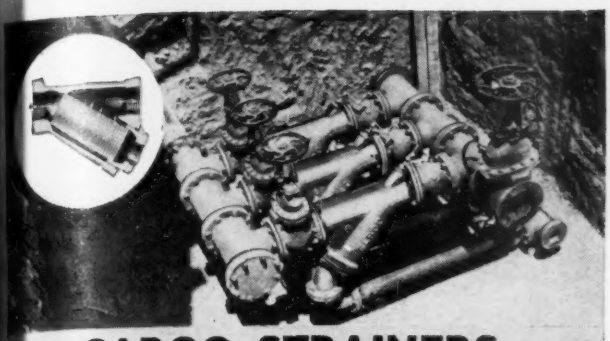
for Electroplating and other Electrolytic Processes



Columbia Generators embody every feature essential for dependable, 24-hour operation. They are built for electroplating service in sizes of 6 to 20 volts, 500 to 20,000 amperes, for anodic treatment of aluminum in sizes of 40, 50, and 60 volts, 500 to 3,000 amperes. Columbia Generators for other electrolytic processes range from ½ to 250 KW, 100 to 40,000 amperes, 6 to 60 volts. Write for full information.

COLUMBIA ELECTRIC MFG. CO.
4519 HAMILTON AVE., N.E. • CLEVELAND 14, OHIO

Chicago Office — 1525 E. 53rd St.



SARCO STRAINERS

PROTECT { EQUIPMENT, PROCESSES AND PRODUCTS

Sarco Strainers are effective and inexpensive insurance against costly shut-downs and heavy repair bills caused by dirt or scale in pipe lines. Keep a supply on hand and slip them in whenever changes are made. The cost is negligible.

Sarco strainers are used to strain such products as syrup, varnish, orange juice, fuel and lubricating oils in the process of manufacture. Chemical and steel industries using large quantities of river water employ strainers on pipe lines up to 8 inches.

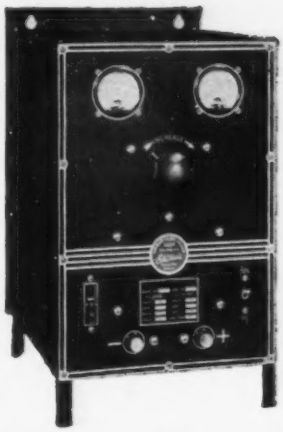
Standard Sarco strainers are made in four types, ¼" to 8" for pressures up to 900 pounds. Scraper strainers, hand or motor operated, ¾" to 8" and 200 pounds. Ask for Bulletin No. 1200.

200

SARCO SAVES STEAM

SARCO COMPANY, INC.
475 Fifth Avenue, New York 17, N. Y.
SARCO CANADA, LTD., 85 Richmond St. W., TORONTO 1, ONT.

HERE'S THE VARIABLE PLATER WITH THE EXTRA FEATURES



Output continuously variable from zero to full rating by one control. . . . Richardson-Allen Variable Platers are supplied in Single and Double Units. . . . Can be combined to increase power rating. . . . Output voltmeter and ammeter. . . . Automatic protection against fan failure and ventilation restrictions on fan cooled units. . . . Longer life Selenium Rectifier. . . . Wall or bench mounted. . . . Sturdily and compactly built.

Model	Amps.	Volts	Power Source	Cooling Type
D 190A	25	6	115 V. AC Single Phase 60 Cycles	Convection
D 191A	37/75	12/6	115 V. AC Single Phase 60 Cycles	Fan
D 207A	75/150	12/6	115 V. AC Single Phase 60 Cycles	Fan

Above models are available in 220 V. AC Single Phase 60 Cycles and 115 V. Single Phase 25 Cycles

For special Selenium D.C. power requirements write for Rectification Questionnaire and literature.

A few choice territories are still available in the United States.

RECTIFIER DIVISION

RICHARDSON-ALLEN Corporation

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A PRECIOUS METAL COMPLEX SALT FOR THE PLATING TRADE

Renders Electro-Silver Plate Harder, Longer Lasting —Tarnish Resistant.

Easy to use—No Extra Work.

Moderately Priced.

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GRANIUM "A" for Platinum & Gold
GRANIUM "B" Cyanide for Electro-Platers
GRANIUM "C" Aluminum & Magnesium
GRANIUM "D" Produces Bronze from copper without tin or zinc.

Write for full information.

GRANIUM PRODUCTS

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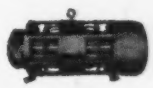
Chemical Engineers since 1905

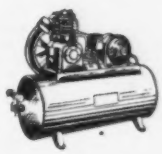
J. HOLLAND & SONS, Inc.

Electroplating and Finishing Equipment and Supplies



MOTOR GENERATOR SETS
All Sizes and Types
Rheostats 50-1500 amperes with or without meters.

V-DRIVE POLISHING LATHES
Sizes 3-15 horsepower. Complete unit is ball-bearing, totally enclosed, Sturdy construction.



SPRAY PAINTING EQUIPMENT
Spray guns, Air compressors, Spray booths and complete paint finishing units. Baking ovens.

J. HOLLAND & SONS, Inc.

276 South Ninth Street Brooklyn 11, N. Y.
AT BROADWAY

Maintenance Paint

Complete information on the new Pen-Kote 500 chemical-resistant maintenance paint is given in an illustrated bulletin announced by *Peninsular Chemical Products Co.*, Van Dyke (Detroit), Michigan.

Illustrations of typical jobs show how this quick-drying, odorless protective coating is readily applied to heated, wet, and porous surfaces of all kinds. Unretouched photographs of test strips demonstrate the protection provided by a single coat of Pen-Kote 500 against hot acids, alkalis and water; and other distinctive features are explained in detail.

This new bulletin is available on request from Peninsular Chemical Products Co., 6795 East Nine Mile Rd., Dept. MF, Van Dyke, Mich.

Air Power Catalog

Mead Specialties Co., 4120 North Knox Ave., Chicago 41, Ill., announces a new edition of their air-operated devices catalog which is now ready for distribution. In addition to several entirely new items being made available to industry for the first time, the Mead Air Power Catalog lists, illustrates and describes the following air-operated devices: presses, vises, collet fixtures, work holders, work feeders, filter and pressure regulators, etc. It also gives actual examples of various Air Power set-ups.

About 50% of the Catalog describes sixteen different types of Air Cylinders, some horizontal thrust models and others of vertical thrust, using strokes ranging from ⅝ inches in some models to 3 inches and more in others and with power from 1 to 23 times.

Manufacturers are invited to submit their individual work-holding problems to Mead for engineering suggestions. As the supply of the new Mead Air Power Catalog is limited, write for your own copy today to Mead Specialties Co., Dept. MF, 4120 North Knox Ave., Chicago 41, Ill.

Metal Cleaning and Finishing

An attractive 48-page book containing over 80 photographic illustrations and detailed information on the design and application of Howard metal cleaning and finishing machinery has been prepared by the *Howard Engineering & Manufacturing Co.*, Dept. MF, 2290 Buck St., Cincinnati 14, Ohio.

All features of Howard Machines are fully and clearly described, including their engineering design and construction, adaptability to every phase of metal cleaning and finishing, ease of control, and automatic operating devices. Numerous improvements pioneered by Howard and available only in Howard machines are also illustrated.

Among the types of machines illustrated and described are: cabinet type and conveyor type metal cleaners and finishers; monorail washers, rotary washers and small parts washers; tumbling, deburring and burnishing machines; hot air dryers and ventilators; and solvent cleaners.

There is a separate section on machines of special design, custom-built by manufacturer to meet unusual requirements. An important feature of the book, too, is profusely illustrated details of construction, information which engineers will particularly appreciate. There is also an exhaustive treatment of the various processes involved in metal cleaning and finishing. This catalog is available without charge if requested on your business letterhead.

TANK RHEOSTAT

(*Concluded from page* 109)

The 150 ampere rheostat described affords the following current settings:

5 Amperes	55	105
10	60	110
15	65	115
20	70	120
25	75	125
30	80	130
35	85	135
40	90	140
45	95	145
50	100	150
		155

The application of this unit is not limited to 3 volt drop. If used as a 2 volt drop unit (i.e., 4 volts on the tank 6 volt line) it will have ⅔ the capacity in amperes or as a 1 volt drop ⅓ the capacity in amperes, etc. It will also stand an overload in amperes and volt drop but for a higher voltage drop it is recommended that the proper rheostat be selected for the application.

AN IMPORTANT MESSAGE TO PLANT MANAGEMENT

Regarding Control of

SKIN IRRITATIONS

TARBONIS cuts absenteeism! Dermatitis due to cutting oils, chemical irritants, metal dust, etc., has been practically eliminated in many plants through the use of TARBONIS.

Not merely a protective, TARBONIS is also effective in clearing up a high percentage of stubborn skin conditions encountered in industry. Easy to apply—nothing to remove. Pleasant, odorless, greaseless, stainless.

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